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Review

Risk Assessment Approaches for *Ophraella communa* as a Biological Control Agent for *Ambrosia artemisiifolia* in Agricultural Landscapes of Southeastern Central Europe: A Review

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Abstract

Common ragweed, *Ambrosia artemisiifolia* (Asteraceae), is an invasive weed that causes problems in cropping systems and to human health both in its native range in North and Central America and the introduced range in Europe, Asia, Africa, and Australia. *Ophraella communa*, an herbivorous chrysomelid beetle from North America, was accidentally introduced into East Asia and Europe, where it significantly reduces weed populations and pollen production. Despite extensive research on its host specificity and risk assessment, the potential environmental risk of this biological control agent in southeastern Central Europe, one of the most heavily invaded areas by *A. artemisiifolia*, remains to be determined. This literature review attempts to summarize the results of host-range testing conducted so far and identifies plant taxa native to southeastern Central Europe that have not been tested yet. The results suggest that the host range of *O. communa* is not yet entirely clear, but may include some plant species from the tribes Heliantheae, Inuleae, Anthemideae, Cardueae, Astereae, and/or Coreopsideae. So far, only some of the 21 genera from those tribes with species in southeastern Central Europe have been tested. We therefore suggest further host specificity studies with representatives of these plant genera to fully assess the potential non-target risks by *O. communa* in agricultural and natural habitats.

Keywords: common ragweed; ragweed beetle; fundamental host range; realized host range; central European risk assessment

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1. Introduction

For more than a century, classical biological control has been successfully used to manage invasive weeds [1]. One of the most problematic invasive weeds worldwide is the

North American-origin common ragweed (*Ambrosia artemisiifolia;* Asteraceae: Heliantheae: Ambrosiinae). It has invaded Europe, Asia, Africa, and Australia [2]. It is particularly common in disturbed environments, such as in urban areas, construction sites, or agricultural ecosystems, where it competes with arable crops [3,4]. In addition, its pollen is highly allergenic for humans, causing heavy allergies with symptoms like rhinitis, asthma, and others [5]. In the USA, the pollen of *A. artemisiifolia* is the principal source of allergenic pollen, potentially affecting approximately 50% of people predisposed to developing allergies [6]. In the European Union, between 23 and 34 million people are estimated to be sensitive to the pollen of *A. artemisiifolia,* and this number may increase to 62–79 million by 2060 [7]. At least 10% of the human population of the Central European and Mediterranean regions are currently victims of allergies caused by this plant [8]. This is because *A. artemisiifolia* releases a large amount of highly allergenic pollen that is wind-dispersed at large distances [9]. Southeastern parts of Central Europe such as the Pannonian basin are among the most affected areas in Europe, with a 54% prevalence of pollen sensitization [10,11]. In summary, about 13 million Europeans are currently suffering from allergies caused by *A. artemisiifolia*, which costs affected countries approximately EUR 7.4 billion per year [12].

Apart from public health concerns, *A. artemisiifolia* is a problem for agriculture and the environment [2]. In agricultural landscapes, this weed is particularly problematic in spring-sown, wide-row crops such as maize, sunflower, and soybeans [3]. In France, some 4% of farming territory is affected by *A. artemisiifolia,* and about EUR 170 million are lost each year [13]. In Hungary, *A. artemisiifolia* has become the most significant weed in arable lands in the last decade and is most widespread in stubble fields and late-summer maize fields [14]. According to Knolmajer et al. (2024) [3], a density of 10 *A. artemisiifolia* plants per 10 m^2 can reduce maize yield by 25%, and 20 to 100 plants per 10 m^2 by 30 to 33%.

Farmers are applying various management practices to control this non-native weed, including herbicides. There are numerous active substances that are effective against *A. artemisiifolia*, but not all can be used in each farming situation. For example, in China, aminopyralid was reported to be efficient in controlling *A. artemisiifolia* [15]. In Hungary, fluorchloridon and propisochlor showed similar results [16]. Often, a combination of ingredients such as fluorchloridon, imazamox, oxyfluorfen, propisochlor, S-metolachlor, pendimethalin, or dimethenamid-P may be needed to reach sufficient efficacies in controlling *A. artemisiifolia* [16]. However, there is an increasing number of cases of herbicide resistance in *A. artemisiifolia* populations [17]. For example, *A. artemisiifolia* seems to have developed resistance to acetolactate synthase (ALS) and protoporphyrinogen oxidase (PPO) inhibitor type of herbicides in Delaware (USA) due to mutations in ALS (W574L) and PPO (R98L in PPX2) [18]. Apart from resistance, the biggest problem is that many herbicides cannot be used in broad leaf crops such as soybean or in crops that are closely related to *A. artemisiifolia* such as sunflower due to the lack of highly selective herbicide options [19]. Moreover, most herbicides cannot be used once the crop reaches a specific growth stage, even in crops like maize, and because of adverse effects on the crop and yield [20]. This makes the management of this invasive weed highly challenging. Furthermore, most herbicides cannot be applied in various invaded areas that are difficult to access or where use is prohibited (e.g., the border of rivers, wild habitats, etc.).

One promising tool within an integrated pest management approach is classical biological control, e.g., using the North American herbivorous leaf beetle *Ophraella communa* (Coleoptera: Chrysomelidae). Both adults and larvae of this beetle feed on *Ambrosia* species [21,22]. Females lay eggs in clusters, and the eggs hatch after 5–6 days [23]. *Ophraella communa* has three larval stages that feed on the host plants [24]. Larval development takes about 12 days at 25 °C, which may shorten to 7 days when the temperature increases to 28 °C [25]. Adults emerge from pupae within about 7 days [25,26]. This natural enemy of *A.*

artemisiifolia is of North American origin but was accidentally introduced and first reported in China in 2001 and in Europe in 2013 [27]. Since then, it has been studied extensively in laboratory and field experiments, and subsequently used as biological control agent against *A. artemisiifolia* in East Asia [28]. An experiment conducted in 2008 and 2009 in China demonstrated that increasing the initial release density of *O. communa* adults leads to an increasing reduction in plant height and number of branches of *A. artemisiifolia*. Also, low densities of a few adults per plant released at early plant growth stage, or 12 adults per plant at later growth stages, successfully suppressed growth and branching of *A. artemisiifolia*, indicating a better effectiveness in managing the weed compared to chemical control [28].

In Europe, this beetle was detected in northern Italy in 2013 [27,29]. It quickly started to defoliate populations of *A. artemisiifolia* and reduced pollen production in Italy and Switzerland [14]. In the Milano region of Italy, *O. communa* reduced the airborne concentration of *A. artemisiifolia* pollen by 86% [30]. The biological control successes in China [31] and parts of Europe [32] call for a wider use of this beetle in areas infested by *A. artemisiifolia*.

Because *O. communa* was accidentally introduced into East Asia and Europe, a comprehensive risk assessment was not conducted prior to its establishment in these regions [24]. In fact, risk assessments had started when the beetle was detected in those regions. In contrast, Australia rejected this beetle as a biological control agent since it can complete its life cycle on sunflower (*Helianthus annuus*, Asteraceae: Heliantheae) [27]. However, later, Dernovici et al. 2006 [33] indicated that *O. communa* is unlikely to significantly damage sunflowers under field conditions. Although *O. communa* can indeed complete its life cycle on a sunflower, life table analyses revealed that it is a suboptimal host and that *O. communa* cannot establish permanent populations on this non-target species under field conditions [33]. Host specificity studies conducted in China under field conditions showed that the risk of non-target effects on cultivated sunflower is low. Adults may occasionally feed on sunflower, but females rarely lay eggs, and larval survival is low [34,35]. Since 2007, *O. communa* has been mass-reared and actively distributed in China and is considered a highly successful biological control agent [36].

In classical biological control, the prediction of the safety or potential risks of a biological control candidate is based on a well-established standard procedure of risk assessment. Using the centrifugal phylogenetic approach [37], test plants are selected for host specificity testing, usually first in no-choice and choice situations in the laboratory, and then, if needed, under field conditions. This is with the aim of understanding the fundamental host range of a biological control agent, which refers to all plant species on which an insect can complete its development. It reflects the insect's genetically determined physiological capacity for host use, and is therefore also called the physiological host range. In contrast, the realized host range is a part of the fundamental host range that reflects the situation under natural conditions [38,39].

As for *O. communa*, host-range studies conducted in southern and western Europe, East Asia, and Australia indicate that the fundamental host range is restricted to the tribes Heliantheae and Inuleae [27,33,40]. This suggests that the only European plant species that may be at risk of attack by *O. communa* are *Ambrosia maritima*, which is the only native European representative of the tribe Heliantheae, and representatives of the genus *Inula*. In addition, non-native economically important plant species such as *H. annuus* and some ornamentals in the tribe Heliantheae should be considered for risk assessments as well.

However, as a European-wide risk assessment is recommended for classical biological control agents against invasive plant species [41], there is a need to also identify and test critical test plant species native to so far under-studied European regions. Although western Europe has been well covered by host specificity studies for *O. communa*, some regions of Central or Eastern Europe may still warrant further studies. This is particularly true for the southeastern region of Central Europe, such as the Pannonian basin, which harbors a high botanical diversity and is a hotspot of *A. artemisiifolia* invasion [42].

Therefore, we conducted a literature review to summarize the current knowledge on the host range of *O. communa* and to identify potential knowledge gaps that may hinder a final conclusion of the fundamental and realized host range of this promising biological control agent. We aimed to identify yet untested plant genera that are native to southeastern regions of Central Europe, that are relatively closely related to *A. artemisiifolia*, and therefore warrant investigation. The overall objective was to suggest which plant species should be included in additional host-range studies with *O. communa* in a European-wide risk assessment for this biological control agent.

2. Materials and Methods

We first conducted a literature review to assess the host range of the different life stages of the biological control agent *O. communa* The scientific databases Web of Science [43], CAB Direct [44], and Scopus abstracts [45] were used. We applied the search terms "*Ophraella communa*" AND "host range"; or "*Ophraella communa*" AND "host specificity"; or "*Ophraella communa*" AND "risk assessment"; or "*Ophraella communa*" AND "non-target plants". Inclusion criteria were (i) peer-reviewed publications in English or non-English with sufficiently detailed English abstracts and (ii) official reports of plant health authorities or other studies that provided clear and reliable information for risk assessments such as the host-range experimentation with *O. communa*. To reduce the risk of duplication bias, we carefully checked publications, especially from the same geographic areas. A total of 26 relevant and sufficiently detailed publications were found and thoroughly reviewed such as for data on attack rates (i.e., whether a plant was attacked by larvae and adults or not), feeding data (i.e., whether larvae or adults were recorded feeding or not), survival data (i.e., if larvae survived to pupae or adults, and if adults survived long on tested plant or not), or egg-laying data (i.e., if eggs were found on tested plants or not). The review data were divided into whether they originated from no-choice or choice trials and whether they were conducted under laboratory or field conditions.

All attacked plant species in any of those tests were used to predict the host range of *O. communa.* When interpreting the results, we distinguished between the fundamental and the realized host range. The fundamental host range, which is also called the physiological host range, reflects the insect's genetically determined physiological and behavioral capacity for host use. Reports from field observations were used to try to describe the realized host range, which is a part of the fundamental host range and comprises those plants from the fundamental host range that are used under natural conditions.

The Open Herbarium Taxonomy Explorer [46] and CAB Direct [44] were used to specify the taxonomic names and relationships of the plant species tested.

To determine the geographic distribution of plant species potentially at risk, the databases Plants of the World Online [47], World Flora Online [48], and CAB Direct [44] were used, as well as the taxonomic literature [49–56]. Climate matching was not considered in this analysis.

Plant genera proposed for host specificity testing were selected by following the centrifugal phylogenetic method [37,57], which is the standard approach used in weed biological control to select plant species for host-specificity testing. This method aligns with internationally recognized guidelines such as the IOBC and EPPO global standards [57,58].

We focused on plant taxa that are native to Europe, and particularly to southeastern Central Europe, such as the Pannonian basin, which is a region most suffering from *A. artemisiifolia* invasion [47]. The proposed plant genera were selected based on the following criteria: close phylogenetic relatedness to *A. artemisiifolia*, native range focusing on southeastern Central Europe, economic importance including ornamental species and crops, nature conservation relevance, especially Red List species (endangered or protected), and not yet being tested.

3. Results

3.1. Host Range of O. communa Under Laboratory Conditions

Feeding and/or survival of *O. communa* larvae have been studied under laboratory conditions on at least 48 plant species, spanning 28 genera from eight tribes in the Asteroideae or Carduoideae subfamilies of Asteraceae (Table 1). Based on these studies, the fundamental host range of larvae appears to include several genera in two tribes, i.e., the Heliantheae and Inuleae. Both are in the subfamily of Asteroideae of the Asteraceae family. Larvae were found to successfully develop beyond early stages, at least to some extent, on 10 plant species. These include three species of *Ambrosia* (i.e., *A. artemisiifolia*, *A. psilostachya*, *A. trifida*), *Helianthus annuus* (several cultivars), *H. tuberosus*, *Parthenium hysterophorus*, *Xanthium orientale*, *X. sibiricum, and X. strumarium* in the Heliantheae tribe, *and Dittrichia graveolens* (syn. *Inula graveolens* and *Erigeron graveolens*) in the Inuleae (Table 1). Among these, full larval development to the pupal or adult stage was observed on seven plant species; this is on *A. artemisiifolia*, *A. trifida*, *H. annuus* (several cultivars), *H. tuberosus*, *X. orientale*, and *X. sibiricum* in the Heliantheae, *and D. graveolens* in the Inuleae. Larvae did not complete development on plant species in five tribes, i.e., Anthemideae, Astereae, Coreopsideae, and Eupatorieae from the Asteroideae subfamily, and Cardueae from the Carduoideae subfamily.

In more detail, choice experiments between test plants and *A. artemisiifolia* under laboratory conditions showed that larvae attack and develop on almost the same plant species as under no-choice conditions. However, larvae fed but did not survive [59,60], or information is lacking for survival on the *Parthenium* species [61].

Feeding and/or survival of *O. communa* adults have been studied under laboratory conditions on 50 plant species, spanning 34 genera from 15 tribes in the Asteroideae and Carduoideae subfamilies of the Asteraceae family, as well as in the Papilionoideae (Fabaceae), Papaveroideae (Papaveraceae), Panicoideae and Pooideae (Poaceae), and Polygonoideae (Polygonaceae). Thirty-eight species in 26 genera have been studied for egg laying (Table 1). The fundamental host range of adult feeding is difficult to describe based on those studies, but it is broader than that of the larvae. Adults were found to feed on at least 17 plant species within the Heliantheae or Inuleae tribes in the Asteroideae subfamily, as well as on one species in the Cardueae tribe in the Carduoideae subfamily. These include species from several genera, such as from *Ambrosia* (*A. artemisiifolia*, *A. psilostachya*, *A. confertiflora*, *A. cumanensis*, *A. trifida*, from *Helianthus* (*H. annuus*, *H. tuberosus*), *Iva* (*Iva frutescens*), *Parthenium* (*P. hysterophorus*), *Xanthium* (*X. orientale*, *X. sibiricum*, *X. strumarium*) in the Heliantheae tribe, and from *Dittrichia* (*D. graveolens*, syn. *Inula graveolens* and *Erigeron graveolens*), and *Pentanema* (*Pentanema hirtum*, *P. britanicum*, *P. helveticum*, *P. salicinum*) in the Inuleae tribe of the Asteroideae subfamily (Table 1). They also include *Centaurea* (*Centaurea nigrescens*) in the Cardueae tribe in the Carduoideae subfamily.

Table 1. Review of host-range studies of *Ophraella communa* (Coleoptera: Chrysomelidae) under laboratory or field conditions. *Ophraella communa* is a major herbivore of *Ambrosia artemisiifolia* (Asteraceae: Helianthinae). The 26 studies found by Web of Science [43], and CAB Direct [44] were reviewed Taxonomic trees were defined using POWO Plants of the World Online [47], N = no attack reported, Y = attack reported, NR = no result reported for a studied test plant regarding *O. communa* feeding, oviposition, or survival, and therefore considered as not yet studied.

Taxonomy			**Larvae**						**Adults**									
			Fundamental Host Range						**Fundamental Host Range**									
Family	**Subfamily**		**Laboratory**				**Field (Realized Host Range)**		**Laboratory**						**Field (Realized Host Range)**			
			No-Choice		**Choice**				**No-Choice**			**Choice**						
Species	**Subtribe**	**Tribe**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Egg Laying**	**Feeding**	**Survival**	**Egg Laying**	**Feeding**	**Survival**	**Egg Laying**	**Source**
Amaranthaceae	**Chenopodioideae**																	
Chenopodium album	Chenopodiinae	Chenopodieae					N	N							Y			[62]
Asteraceae	**Asteroideae**																	
Achillea millefolium	Achilinae	Anthemideae					N	N							Y		N	[62]
Artemisia absinthium	Artemisiinae	Anthemideae					N	N							NR		NR	[63]
Artemisia annua	Artemisiinae	Anthemideae				N	N	N							Y		N	[64]
Artemisia molinieri	Artemisiinae	Anthemideae	N	N					N	N	N							[40]
Artemisia verlotiorum	Artemisiinae	Anthemideae					Y	Y							Y	Y	Y	[62,65]
Matricaria chamomilla	Matricariinae	Anthemideae	N	N		N			N	N	N							[40]
Leucanthemum maximum	Leucantheminae	Anthemideae			N	N						N	N	N				[61]
Bellis perennis	Asterinae	Astereae	N	N		N			N	N								[40]
Chrysopsis villos	Chrysopsidinae	Astereae	N	N														[66]
Erigeron annuus	Conyzinae	Astereae					N	N							Y	N	N	[62]
Erigeron sumatrensis	Conyzinae	Astereae	N	N					N	N	N							[40]
Bidens cernua	Coreopsidinae	Coreopsideae			N	N	N	N	N	N					Y	NR	N	[27,40]
Bidens frondosa	Coreopsidinae	Coreopsideae					N	N							N	N	N	[40,66]
Cosmos sulphureus	Coreopsidinae	Coreopsideae	N	N	N	N			N	N								[40]
Dahlia pinnata	Coreopsidinae	Coreopsideae	N	N	N				N	N	Y							[61]
Ageratum houstonianum	Eupatorieae	Eupatorieae	N	N			N		N	N	N						N	[61]
Ambrosia artemisiifolia	Ambrosiinae	Heliantheae	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	[34,40,59,67,68]
Ambrosia confertiflora	Ambrosiinae	Heliantheae					Y	Y							Y	Y	Y	[61]
Ambrosia cumanensis	Ambrosiinae	Heliantheae					Y	Y							Y	Y	Y	[61]
Ambrosia psilostachya	Ambrosiinae	Heliantheae			Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	[61]
Ambrosia trifida	Ambrosiinae	Heliantheae	Y	Y	Y	Y	Y	Y	Y								Y	[29,40–61,64,67,69–72]
Iva axillaris	Ambrosiinae	Heliantheae													Y	Y	Y	[27,61]
Iva frutescens	Ambrosiinae	Heliantheae			N	N						Y	Y	Y				[61,66]

Table 1. *Cont.*

Taxonomy			Larvae						Adults									
			Fundamental Host Range						Fundamental Host Range									
Family	Subfamily		Laboratory				Field (Realized Host Range)		Laboratory						Field (Realized Host Range)			
			No-Choice		Choice				No-Choice			Choice						
Species	**Subtribe**	**Tribe**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Egg Laying**	**Feeding**	**Survival**	**Egg Laying**	**Feeding**	**Survival**	**Egg Laying**	**Source**
Parthenium hysterophorus	Ambrosiinae	Heliantheae			Y							Y	Y	Y				[61]
Xanthium italicum	Ambrosiinae	Heliantheae					N	N							N	N	Y	[62]
Xanthium orientale	Ambrosiinae	Heliantheae	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	[40]
Xanthium strumarium	Ambrosiinae	Heliantheae	Y		Y				Y	Y	Y							[29,60,62,67]
Helianthus annuus	Helianthinae	Heliantheae	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	[29,33,59,60,62,63,73–75]
Helianthus annuus AXELL	Helianthinae	Heliantheae	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y				[40]
Helianthus annuus BUFFALO	Helianthinae	Heliantheae	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y				[40]
Helianthus annuus CELESTO	Helianthinae	Heliantheae	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	Y		Y	[40]
Helianthus annuus Extra sol	Helianthinae	Heliantheae					Y	Y							Y	Y	Y	[40]
Helianthus annuus Girasol	Helianthinae	Heliantheae					Y	Y							Y	Y	Y	[40]
Helianthus annuus IDILIC	Helianthinae	Heliantheae	Y	Y					Y	Y	Y	Y	Y	Y				[40]
Helianthus annuus Italy	Helianthinae	Heliantheae					Y	Y							Y	Y	Y	[40]
Helianthus annuus LG5687	Helianthinae	Heliantheae					Y								Y	Y	Y	[40]
Helianthus annuus MAS89	Helianthinae	Heliantheae	Y	Y					Y	Y	Y	Y	Y	Y				[40]
Helianthus annuus P6P64HE118	Helianthinae	Heliantheae	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y				[40]
Helianthus annuus veronica	Helianthinae	Heliantheae	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y				[40]
Helianthus tuberosus	Helianthinae	Heliantheae	Y	Y					Y	Y	Y	Y	Y	Y	Y	Y	Y	[29,40,59,64,68]
Helianthus decapetalus	Helianthinae	Heliantheae													Y			[76]
Zinnia elegans	Zinniinae	Heliantheae			N	N	N	N				N	N		N	N	N	[61,64]
Buphthalmum salicifolium	Inulinae	Inuleae	N					N							Y		NR	[29]
Carpesium cernuum	Inulinae	Inuleae	N	N						N	N				N	N	N	[27,40,66]
Dittrichia graveolens (syn. *Inula graveolens* & *Erigeron graveolens*)	Inulinae	Inuleae	Y	Y	Y	Y	Y	Y							Y	Y	Y	[27,29,68]
Inula helvetica	Inulinae	Inuleae	N														N	[77]
Pallenis spinosa	Inulinae	Inuleae	N	N		N			N	N	N							[40]
Pentanema bifrons	Inulinae	Inuleae	N	N					N									[40]
Pentanema britanicum	Inulinae	Inuleae	N	N						N	Y				N	N	N	[27,29,40]
Pentanema conyzae	Inulinae	Inuleae	N				N	N							N	N	N	[27]

Table 1. *Cont.*

Taxonomy			**Larvae**						**Adults**									
			Fundamental Host Range						**Fundamental Host Range**									
Family	**Subfamily**		**Laboratory**				**Field (Realized Host Range)**		**Laboratory**						**Field (Realized Host Range)**			
			No-Choice		**Choice**				**No-Choice**			**Choice**						
Species	**Subtribe**	**Tribe**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Feeding**	**Survival**	**Egg Laying**	**Feeding**	**Survival**	**Egg Laying**	**Feeding**	**Survival**	**Egg Laying**	**Source**
Pentanema helveticum	Inulinae	Inuleae	N	N	N	N			Y	Y	Y	Y	Y	Y				[27,29,40]
Pentanema hirtum	Inulinae	Inuleae	N	N	N	N	N	N	Y									[27]
Pentanema (syn. *Inula*) *salicinum*	Inulinae	Inuleae	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y			N	[27]
Pentanema spiraeifolium	Inulinae	Inuleae						N							Y	Y	N	[27]
Xerolekia speciosissima	Inulinae	Inuleae	N	N											Y			[61,64]
Tagetes lucida	Tagetinae	Tageteae			N	N						N	N	N				[61]
Asteraceae	**Carduoideae**																	
Cynara scolymus	Caduinea	Cardueae			N	N			N			N	N					[61]
Carthamus tinctorius	Centaureinae	Cardueae			N	N						N	N	N				[61]
Centaurea nigrescens	Centaureinae	Cardueae	N	N		N	N			Y							Y	[27,29,62,77]
Centaurea solstitialis	Centaureinae	Cardueae	N	N					N									[41]
Centaurea sp.	Centaureinae	Cardueae					N	N							Y		Y	[62]
Fabaceae	**Papilionoideae**																	
Trifolium sp.	Trifoliinae	Trifolieae					N	N							Y	N	Y	[37]
Papaveraceae	**Papaveroideae**																	
Papaver rhoeas	Corydalinae	Papaverae					N	N										[62]
Poaceae	**Panicoideae**																	
Sorghum halepense	Sorghinae	Andropogoneae					N	N	N			N			N	N	N	[62]
Poaceae	**Pooideae**																	
Arrhenatherum elatius	Aveninae	Poeae					N	N									N	[62]
Lolium sp.	Loliinae	Poeae					N	N									N	[62]
Holcus lanatus	Holcinae	Poeae						N									N	[62]
Polygonaceae	**Polygonoideae**																	
Persicaria maculosa	Persicariinae	Persicarieae					N	N								N		[62]
Polygonum sp.	Polygoninae	Polygoneae					N	N								N	N	[62]

Adults did not feed or survive on plant species in the Anthemideae, Astereae, Eupathorieae, or Tageteae tribes in the Asteroideae subfamily. They also did not feed or survive on species in the Trifolieae tribe in the Papilionoideae subfamily (Fabaceae), nor on species in the Papavereae tribe in the Papaveroideae subfamily (Papaveraceae), species in the Andropogoneae tribe in the Panicoideae subfamily, or species in the Poeae tribe in the Pooideae subfamily (Poaceae). Finally, no feeding was observed on species in the Persicarieae tribe in the Polygonoideae subfamily (Polygonaceae).

Egg laying was recorded on 11 plant species in seven genera in the Coreopsideae, Heliantheae, and Inuleae tribes in the Asteroideae subfamily. These include egg-laying on *A. artemisiifolia*, *A. psilostachya*, *H. annuus*, *H. tuberosus*, *I. frutescens*, *P. hysterophorus*, *X. orientale*, and *X. strumarium* in the Heliantheae, on *P. britanicum*, *P. helveticum* in the Inuleae tribe, and on *Dahlia pinnata* in the Coreopsideae tribe. Egg laying was not observed on plant species in the Anthemideae, Astereae, Eupatorieae, or Tageteae tribes of the Asteroideae subfamily. Also, no egg laying was observed on the species in the Cardueae tribe of the Carduoideae subfamily (Table 1).

3.2. Host Range of O. communa Under Field Conditions

There is taxonomically slightly broader information available on the host use of *O. communa* from field studies than from laboratory studies (Table 1). Nevertheless, field data on larvae, pupae, adults, and eggs are limited. Therefore, the realized host ranges of the different life stages cannot be reliably concluded.

Feeding larvae were recorded from the field on 11 plant species from five genera in three tribes. These are *A. artemisiifolia*, *A. psilostachya*, *A. confertiflora*, *A. cumanensis*, *A. trifida*, *H. annuus*, *H. tuberosus*, *X. strumarium,* and *Iva axillaris* in the Heliantheae, *Artemisia verlotiorum* in the Anthemideae, and *D. graveolens* (syn. *Inula graveolens* and *Erigeron graveolens*) in the Inuleae tribes, thus all in the Asteroideae subfamily. No larvae were found on plants in the Chenopodieae tribe of the Chenopodieae subfamily, nor on plants of the Astereae and Coreopsideae tribes in the Asteroideae subfamily, Cardueae in Carduoideae, Trifolieae in Papilionoideae, Papavereae in Papaveroideae, Andropogoneae in Panicoideae, Poeae in Pooideae, or Persicarieae and Polygoneae in the Polygonoideae subfamily.

In general, the realized host range of adults of *O. communa* appears wider than that of the larvae. Heavy leaf damage and good survival of adults were observed on *A. artemisiifolia* only. Adult feeding was recorded on 20 non-target plant species in seven tribes; this is on *Erigeron annuus* in the Astereae tribe, *Chenopodium album* in the Chenopodieae, on *Achillea millefolium*, *Artemisia verlotiorum,* and *A. annua* in the Anthemideae, *Centaurea* spp. in the Cardueae tribe, *Bidens cernua* in the Coreopsideae, *Ambrosia psilostachya*, *A. artemisiifolia*, *A. confertiflora*, *A. cumanensis*, *I. axillaris*, *Xanthium orientale*, *X. strumarium*, *Helianthus decapetalus*, and *H. annuus* in the Heliantheae, as well as on *Buphthalmum salicifolium*, *D. graveolens*, *P. spiraeifolium,* and *Xerolekia speciosissima* in the Inuleae tribe, and *Trifolium* spp. in the Trifolieae tribe. No adult feeding was observed on *Sorghum* spp. in the Andropogoneae tribe of Panicoideae subfamily of Poaceae, and not on plants in the Persicarieae and Polygoneae tribes of the Polygonoideae subfamily of Polygonaceae.

Eggs were found on 14 plant species in five tribes and three subfamilies under field conditions. This is on *A. verlotiorum* in the Anthemideae, *A. artemisiifolia*, *A. psilostachya*, *A. confertiflora*, *A. cumanensis*, *A. trifida*, *X. italicum*, *X. sibiricum*, *X. strumarium*, *H. annus*, and *H. tuberosus* in the Heliantheae, as well as on *D. graveolens* in the Inuleae tribe in the Asteroideae subfamily. Egg laying was also found on *Centaurea* sp. in the Cardueae tribe of the Carduoideae subfamily, and on *Trifolium* sp. in the Trifolieae tribe of the Papilionoideae subfamily. No egg-laying was observed in the Astereae or Coreopsideae tribes of the Asteroideae subfamily, not on the Andropogoneae tribe of the Panicoideae subfamily, the

Poeae tribe of the Pooideae subfamily (Poaceae), and not on the Polygoneae tribe of the Polygonoideae subfamily (Polygonaceae). For details on the results of adult feeding in no-choice and choice test situations, we refer to Table 1.

3.3. Plant Genera Tested and Not Tested in Tribes Potentially at Risk

Globally, the Asteraceae family covers around 11 subfamilies, 35 tribes [78], and 1600 genera [79]. The six tribes in the Asteraceae family, potentially at risk (Astereae, Heliantheae, Inuleae, Anthemideae, Coreopsideae, Cardueae), contain around 750 genera (Table 1). Only 25 genera (3%) have so far been tested on either larvae and/or adults of *O. communa*. For example, of around 144 genera existing in the Heliantheae tribe, only six genera (4%) have been tested. From around 77 genera existing in the Inuleae tribe, only seven genera (9%) have been tested, as well as four (3%) of 119 genera in the Anthemideae, three (4%) of 85 in the Cardueae, three (1%) of 291 in the Astereae, and three (10%) of 29 in the Coreopsideae tribe. Therefore, from a global perspective, species from up to 725 genera of these six tribes have not been tested so far (table in Supplementary Materials).

3.4. Plant Genera Relevant for Risk Assessments in Europe

Within the tribes Cardueae, Astereae, Heliantheae, Inuleae, Coreopsideae, and Anthemideae potentially at risk, there are about 95 genera present in Europe, of which 22 genera (23%) have been tested so far.

Ophraella communa larvae seem to successfully develop to pupae or adults only on some species in the Heliantheae and Inuleae tribes, with occasional field observations of all life stages on Anthemideae species such as *A. verlotiorum* [62]. Therefore, further larval development tests in a European risk assessment may focus on plant species of not-yet-tested genera of these tribes or closely related tribes (Table 2). This may include species of *Rudbeckia* in the Heliantheae tribe, or of *Chiliadenus*, *Francoeuria*, *Jasonia*, *Limbarda*, *Asteriscus* (syn. *Nauplius*), *Pulicaria*, and *Telekia* in the Inuleae tribe. It may also include species of *Anacyclus*, *Anthemis*, *Archanthemis*, *Castrilanthemum*, *Chamaemelum*, *Chrysanthemum* (syn. *Dendranthema*), *Cladanthus*, *Coleostephus*, *Cota*, *Cotula*, *Daveaua*, *Elachanthemum*, *Glebionis*, *Glossopappus*, *Heteranthemis*, *Hymenostemma*, *Ismelia*, *Lepidophorum*, *Leucanthemella*, *Leucanthemopsis*, *Lonas*, *Mauranthemum*, *Nananthea*, *Phalacrocarpum*, *Plagius*, *Prolongoa*, *Rhodanthemum*, *Santolina*, and *Tanacetum* in the Anthemideae tribe.

To assess the population dynamics of *O. communa* on native European species or crops from plant genera that have already been shown to allow some survival of *O. communa* larvae, such as species of the genus *Dittrichia* or the crop *H. tuberosus*, detailed life table studies could be conducted using the approach taken by Dernovici et al. (2006) [33] with *H. annuus*.

Ophraella communa adults were found feeding on the Cardueae tribe of Carduoideae, as well as on species in the Astereae, Heliantheae, Inuleae, Coreopsideae, and Anthemideae tribes of the Asteroideae subfamily, Chenopodieae of Chenopodioideae, and on Trifolieae of Papilionoideae. The adult host range of chrysomelid beetles tends to be broader than that of larvae, and field observations of adults on plant species not suitable for larval development can be explained by spillover [80]. Nevertheless, further tests (e.g., combined feeding and survival trials) in a European risk assessment with adults could be conducted with plant species in the genera of these tribes or closely related tribes. This may include species in the genera of *Atractylis*, *Berardia*, *Callistephus*, *Cardopatium*, *Carduncellus*, *Carduus*, *Carlina*, *Cheirolophus*, *Cirsium*, *Cnicus*, *Crupina*, *Echinops*, *Femeniasia*, *Galactites* (syn. *Crinitaria*), *Hypacanthium*, *Jurinea*, *Lamyropsis*, *Mantisalca*, *Notobasis*, *Onopordum*, *Phaeopappus*, *Phonus*, *Picnomon*, *Psephellus*, *Ptilostemon*, *Rhaponticoides*, *Rhaponticum* (syn. *Leuzea*), *Saussurea*, *Schischkinia*, *Serratula*, *Silybum*, *Staehelina*, *Tyrimnus*, *Xeranthemum* in the Cardueae, and of *Aster*, *Bellidiastrum*, *Bellium*, *Conyza*, and *Tripolium* in the Astereae. It may also include species of *Rudbeckia* in the *Heliantheae*, of *Asteriscus*, *Chiliadenus*, *Francoeuria*, *Jasonia*, *Limbarda*, *Asteriscus* (syn. *Nauplius*), *Pulicaria*, and *Telekia* in the Inuleae, or of *Coreopsis* in the Coreopsideae. Finally, it may include species of *Anacyclus*, *Anthemis*, *Archanthemis*, *Castrilanthemum*, *Chamaemelum*, *Chrysanthemum* (syn. *Dendranthema*), *Chrysanthoglossum*, *Cladanthus*, *Coleostephus*, *Cota*, *Cotula*, *Daveaua*, *Elachanthemum*, *Glebionis*, *Glossopappus*, *Heteranthemis*, *Hymenostemma*, *Ismelia*, *Lepidophorum*, *Leucanthemella*, *Leucanthemopsis*, *Lonas*, *Mauranthemum*, *Nananthea*, *Phalacrocarpum*, *Plagius*, *Prolongoa*, *Rhodanthemum*, *Santolina*, and *Tanacetum* of the Anthemideae tribe. All those are found in the Asteroideae subfamily of the Asteraceae family (Table 2). Further testing of species in the Chenopodioideae subfamily of the Amaranthaceae family or in the Papilionoideae subfamily of the Fabaceae family may be considered if adult feeding among species in the Asteraceae is widespread.

Ophraella communa adults have so far been observed laying eggs on some species in the Coreopsideae, Heliantheae, Inuleae, and Anthemideae tribes in the Asteroideae subfamily, Carduoideae of the Carduoideae subfamily of Asteraceae, and on Trifolieae of Papilionoideae of Fabaceae. Therefore, to further study the egg-laying behavior of *O. communa*, additional open-field tests could be conducted with plant species in the genera of these tribes or closely related tribes. These may include species of *Rudbeckia* of the Heliantheae tribe, or of *Asteriscus*, *Chiliadenus*, *Francoeuria*, *Jasonia*, *Limbarda*, *Asteriscus* (syn. *Nauplius*), *Pulicaria*, and *Telekia* of the Inuleae tribe. It may also include species of *Anacyclus*, *Anthemis*, *Archanthemis*, *Castrilanthemum*, *Chamaemelum*, *Cladanthus*, *Coleostephus*, *Cota*, *Cotula*, *Daveaua*, *Chrysanthemum* (syn. *Dendranthema*), *Elachanthemum*, *Glebionis*, *Glossopappus*, *Heteranthemis*, *Hymenostemma*, *Ismelia*, *Lepidophorum*, *Leucanthemella*, *Leucanthemopsis*, *Lonas*, *Mauranthemum*, *Nananthea*, *Phalacrocarpum*, *Plagius*, *Prolongoa*, *Rhodanthemum*, *Santolina*, and *Tanacetum* of the Anthemideae tribe, as well as of *Coreopsis* of the Coreopsideae tribe, or *Atractylis*, *Berardia*, *Callistephus*, *Cardopatium*, *Carduncellus*, *Carduus*, *Carlina*, *Cheirolophus*, *Cirsium*, *Cnicus*, *Crupina*, *Dipterocome*, *Echinops*, *Femeniasia*, *Galactites* (syn. *Crinitaria.*), *Hypacanthium*, *Jurinea*, *Lamyropsis*, *Rhaponticoides*), *Mantisalca*, *Notobasis*, *Onopordum*, *Phaeopappus*, *Phonus*, *Picnomon*, *Psephellus*, *Ptilostemon*, *Rhaponticoides*, *Rhaponticum* (syn. *Leuzea*), *Saussurea*, *Schischkinia*, *Serratula*, *Silybum*, *Staehelina*, and *Xeranthemum* of the Cardueae tribe.

Table 2. Genera in the Anthemideae, Astereae, Coreopsideae, Heliantheae, Inuleae tribes of the Asteroideae subfamily and in the Cardueae tribe of the Carduoideae subfamily, all in the Asteraceae family, that are closely related to *Ambrosia artemisiifolia* (Asteraceae: Helianthinae), and thus have the potential to be part of the host range of *Ophraella communa*. Some 22 of 95 genera (23%) in the tribes with species present in Europe have been tested, and 21 of 56 genera (38%) with species present in southeastern Central Europe. Presence of genera in Europe was assessed as per POWO Plants of the World Online [47], World Flora Online [48], CAB Direct [44], and [49–56]. The table includes species with conservation status in Hungary based on the IUCN Red List [81]: CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, DD = data deficient [81]. NA = not applicable. Proposed test species are species of: genera which (A) are native to the target region, Europe, or (B) are of economic interest (crops, ornamentals) in the target region, and (C) have not yet been tested.

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Asteroideae							
Anthemideae							
Achillea	Eurasia, Northern Africa, North America	Australia, New Zealand, Southern Africa	Yes	No	*Achillea crithmifolia* (NT), *Achillea distans* (DD), *Achillea horanszkyi* (CR), *Achillea ptarmica* (NT), *Achillea tuzsonii* (NT)	Yes	No
Anacyclus	Southern Europe, Western Europe, Northern Africa, Northwestern Asia	Central Europe, Northern Europe, Eastern Europe, North of Southeastern Asia	Yes	Yes	None	No	Yes
Anthemis	Europe, Northern Africa, Western Asia	North America, Centre of South America, Southern Africa, India, Eastern Asia, Australia, New Zealand	Yes	No	*Anthemis cotula* (DD)	No	Yes
Archanthemis	Caucasus, Central Asia, Eastern Europe	None	No	Yes	NA	No	Yes
Artemisia	Northern Africa, Southern Africa, North America, Eastern South America, Central America, Europe, Asia, Oceania	Central and Western South America, Caribbean, Indian Ocean Islands, Pacific Islands, Australia	Yes	Yes	*Artemisia austriaca* (NT), *Artemisia scoparia* (NT)	Yes	No

Table 2. *Cont.*

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Castrilanthemum	Southwestern Europe	None	No	No	NA	No	No
Chamaemelum	Northern Africa, Southwestern Europe, Northern Europe (Great Britain, Ireland)	Western Europe, Central Europe, Eastern Europe, Southern Europe, North America, Oceania	Yes	Yes	None	No	Yes
Chrysanthemum (syn. *Dendranthema*)	North America, Asia, Russia, Eastern and Central Europe	Eastern Europe, Western Europe, Central America, South America, Oceania	Yes	Yes	NA	No	Yes
Chrysanthoglossum	Northern Africa	None	No	No	NA	No	No
Cladanthus	Northern Africa, Mediterranean region, Macaronesia, Western Asia,	North America, South America (Uruguay), Northern Europe	No	No	NA	No	No
Coleostephus	Northern Africa, Western Asia, Southwestern Europe	Western Europe, Central and Eastern Europe, Caribbean, India, Uruguay	No	No	NA	No	No
Cota	Western Europe, Southern Europe, Northern Europe, Eastern Europe, Balkans, North Africa	North America, Russia, Oceania, Atlantic Islands	No	No	NA	No	No
Cotula	Africa, Middle East, Southern Asia, Southeastern Asia, Eastern Asia, Oceania	North America, Western Europe, Southern Europe, Northern Europe, Eastern Europe, Russia	Yes	Yes	None	No	Yes

Table 2. *Cont.*

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Daveaua	Morocco, Portugal, Spain	None		No	NA	No	No
Elachanthemum	Eastern and Central of Asia	None	No	No	NA	No	No
Glebionis	Northern Africa, Western Asia, Central Asia, Southern Europe	Northern and South America, Europe, Asia Oceania, Southern Africa, Ethiopia	Yes	Yes	None	No	Yes
Glossopappus	Northern Africa, Spain, Portugal	None	No	No	NA	No	No
Heteranthemis	Northern Africa, Westen Asia, Southern Europe, Eastern Europe, Western Asia, Central Asia, Southwestern Europe	North America, Central America, South America, Europe, Russia, Southern and Southeastern Asia, Africa, Australia, Pacific and Atlantic Islands	No	No	NA	No	No
Hymenostemma	Spain	None	No	No	NA	No	No
Ismelia	Morocco	Western Europe, Northern Europe, Eastern Europe, Baltic States, Southern Europe, East Asia, Southeastern Asia, California, Mexico	Yes	Yes	None	No	Yes
Lepidophorum	Southwestern Europe	None	No	No	NA	No	No
Leucanthemella	Southeastern Europe, Central Europe, Eastern Asia, Northern Asia	North America, Western Europe	Yes	No	None	No	Yes

Table 2. *Cont.*

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Leucanthemopsis	Western Europe, Northern Africa, Central Europe, Southeastern Europe	None	Yes	No	None	No	Yes
Leucanthemum	Southwestern Europe, Northern Europe, Southern Europe, Eastern Europe, Central Asia, Eastern Asia	North America, Central America and Caribbean, South America, Europe (Denmark, Portugal, Iceland), Africa, Southern and Eastern Asia, Oceania	Yes	Yes	*Leucanthemum margaritae* (DD), *Leucanthemum serotinum* (NT)	Yes	No
Lonas	Northern Africa, Sardegna, Sicilia	Central Europe (Germany), western Europe (France)	No	No	NA	No	No
Matricaria	Eastern Europe, Central Asia	Central Europe (Germany)	Yes	No	*Matricaria tenuifolia* (DD)	Yes	No
Mauranthemum	Northern Africa, Southwestern Europe	Australia, Central Europe, Southern Europe (Italy), North America (California)	No	No	NA	No	No
Nananthea	Africa, South and Southeastern Asia, East Asia, Middle East	Western Europe, Central Europe	No	No	NA	No	No
Phalacrocarpum	Southwestern Europe	None	No	No	NA	No	No
Plagius	Northern Africa, Southern Asia, Western Asia, Central Asia, Southern Europe	Southern Asia, Western Europe	No	No	NA	No	No
Prolongoa	Southwestern Europe	None	No	No	NA	No	No

Table 2. *Cont.*

Subfamily Tribe *Genus*	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Rhodanthemum	Southwestern Europe	None	No	No	NA	No	No
Santolina	Northern Africa, Southwestern Europe, western Mediterranean region	Western Asia, Central Europe, Southeastern Europe, North America, South America	Yes	No	NA	No	No
Tanacetum	Northern Africa, Asia, Europe, North America	South America, South-Central Pacific	Yes	No	*Tanacetum corymbosum* (NT)	No	Yes
Astereae							
Aster	North America, Europe, Asia, Oceania, Northern Africa	Northwest European Russia North-Central Pacific Hawaii	Yes	Yes	Aster amellus (PR), Aster sedifolius (PR)	No	Yes
Bellidiastrum	Europe		Yes	No	None	No	Yes
Bellis	Europe, Western Asia, Central Asia, Northern Africa	North America, South America, South Asia, Australia	Yes	No	NA	Yes	No
Bellium	Eastern and Southern Mediterranean	Great Britain	No	No	NA	No	No
Conyza	South America, North America	Africa, Europe, Asia, Oceania	Yes	No	None	No	No
Galatella (syn. *Crinitaria*)	Eastern Europe, Central Asia, Western Asia, Siberia, Southeastern Europe	Netherlands	Yes	Yes	NA	No	Yes
Tripolium	Eurasia, Northern Africa	Eastern USA	Yes	No	None	No	Yes
Coreopsideae							
Bidens	Central America, Caribbean, South America, North America, Africa, Asia	Global	Yes	No	*Bidens cernua* (NT)	Yes	No

Table 2. *Cont.*

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Cosmos	North America, South America	Tropical Africa, Southern Africa, Eastern Asia, Western Asia, Australia, Southern Europe, Southwestern Europe, Southeastern Europe	Yes	Yes	None	Yes	No
Coreopsis	North America, South America	Southern Tropical Africa, Eastern Asia, Central Asia, Indian Subcontinent, Eastern Europe, Southeastern Europe, Southwestern Europe	Yes	Yes	None	No	Yes
Dahlia	Central America, Mexico	Southern Asia, Southeastern Asia, Central Asia, Europe, South America	Yes	Yes	None	Yes	No
Heliantheae							
Ambrosia	Africa, Western Asia, Southeastern Europe, Southwestern, North America, South America	Northern Europe, Western Europe, Eastern Europe, Central Asia, Southern Asia, Northern Asia, Eastern Asia, Northern Oceania, Pacific Islands,	Yes	No	None	Yes	No
Helianthus	North America	Northern Africa, Southern Africa, Asia, South America, Oceania	Yes	Yes	None	Yes	No

Table 2. *Cont.*

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Iva	North America	Australia, Central Europe, Western Europe	Yes	No	None	Yes	No
Rudbeckia	North America	Northern Africa, Eastern Asia, Central Asia, Eastern Europe, Central Europe, Northern Europe, Southeastern Europe, Southwestern Europe	Yes	Yes	None	No	Yes
Xanthium	Northern Africa, East Asia, Central Asia, Western Asia, Southern Europe, Western Europe, North America, South America	Southern Africa, East Africa, Arabian Peninsula, Australia, Northern Europe, North Asia	Yes	No	None	Yes	No
Zinnia	North America Central America, South America)	Northern Africa, Northeastern Africa, Western Africa, Southern Africa, Indian Ocean Islands, Asia, Europe, Oceania	Yes	Yes	None	Yes	No
Inuleae							
Asteriscus (syn. *Nauplius*)	Northern Africa, Middle East, Eastern Africa South Asia, Southern Europe	Western and Central Europe	No	No	None	No	No
Buphthalmum	Central Europe, Northern Europe (Great Britain), Southern Europe, Western Europe	Malaysia (Jawa)	Yes	No	*Buphthalmum salicifolium* (NT), *Bupleurum longifolium* (EN)	Yes	No

Table 2. *Cont.*

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Carpesium	Asia, Asia, Central Europe, Southeastern Europe, Southwestern Europe	Australia	Yes	No	Carpesium abrotanoides (PR)	Yes	No
Chiliadenus	Northern Africa, Western Asia, Southwestern Europe	None	No	No	NA	No	No
Dittrichia	Northern Africa, Western Asia, Southern Europe, Western Europe,	Southern Africa, Oceania, Central Europe, North America, South America	No	No	NA	Yes	No
Francoeuria	Northern Africa, Tropical Asia, Southern Europe, Canary Islands, Northern Africa	West of North America	No	No	NA	No	No
Inula	Eastern Africa, Central Africa, East Africa, Asia, Southeastern Europe, Southern Europe	Central Europe, Northern Europe, Southwestern Europe, Western Europe, North America, India	Yes	No	*Inula helenium* (PR), *Inula oculus-christi* (PR)	Yes	No
Jasonia	Southwestern Europe	None	No	No	NA	No	No
Limbarda	Northern Africa, Eastern Asia, Southeastern Europe, Southwestern Europe, Northern Europe (Great Britain, Ireland)	None	No	No	NA	No	No

Table 2. *Cont.*

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Pallenis	Northern Africa, Western Asia, Southern Europe, Southeastern Europe, Southwestern Europe	Australia, Northern Europe (Great Britain)	Yes	Yes	None	Yes	No
Pentanema	Eurasia	North America, North of South America	Yes	No	None	Yes	No
Pulicaria	Africa, Asia, Europe	Western North America	Yes	No	None	No	Yes
Telekia	Caucasus region, Western Asia, Eastern Europe, Central Europe, Southern Europe	Northern Europe, Western Europe	Yes	No	None	No	Yes
Carduoideae							
Cardueae							
Atractylis	Northern Africa, Middle East, East Africa, South Asia, Southern Europe	None	No	No	NA	No	No
Berardia	Southern Europe, Western Europe	None	No	No	NA	No	No
Callistephus	China	Western Europe, Eastern Europe, Central Asia, Southern and Southeastern Asia, East Asia, Central America, Caribbean, South America, North America, Oceania	Yes	Yes	None	No	Yes
Cardopatium	Eastern Mediterranean, Southern Europe, Western Europe	None	No	No	NA	No	No

Table 2. *Cont.*

Subfamily **Tribe** ***Genus***	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Carduncellus	Southwestern Europe	None	No	No	NA	No	No
Carduus	Africa, Asia, Europe	Oceania, North America, South America	Yes	No	None	No	Yes
Carlina	Northern Africa, Macaronesia, Asia temperate, Middle Asia, Western Asia, Europe	None	Yes	No	*Carlina acaulis* (PR)	No	Yes
Carthamus	Northern Africa, Europe, all Asia except south and East Asia	Global	Yes	No	*Carthamus lanatus* (NT)	Yes	Yes
Centaurea	All Africa except Southern Africa, all Asia except South and East Asia, Europe,	North America, South America, Australia, East Asia, Southern Africa	Yes	Yes	*Centaurea calcitrapa* (EN), *Centaurea mollis* (EN), *Centaurea pseudophrygia* (DD), *Centaurea solstitialis* (NT), *Centaurea stenolepis* (NT)	Yes	No
Cheirolophus	Northern Africa, Macaronesia, Western Mediterranean	None	No	No	NA	No	No
Cirsium	Eurasia, North America, Northern Africa	Eastern and Southern Africa, South America, Australia	Yes	No	*Cirsium boujartii* (NT), *Cirsium erisithales* (VU), Cirsium furiens (EN)	No	Yes
Cnicus	Africa, Asia, Europe	North America, South America, Caribbean	Yes	No	None	No	Yes
Crupina	Northern Africa, Western and Middle Asia, Europe	North America	Yes	No	None	No	Yes

Table 2. *Cont.*

Subfamily Tribe *Genus*	**Native Range**	**Introduced Range**	**Present in Southeastern Central Europe**	**Includes Species of Economic Interest (Crops, Ornamentals)**	**Red List Species in Hungary**	**Already Tested**	**Proposed For Risk Assessment for Southeastern Central Europe**
Cynara	Northern Africa, Southern Europe, Southwestern Europe, Western Europe, Southeastern Europe, Southwestern Asia	East Africa, Australia, Eastern Europe, Central Europe, North America, South America	Yes	No	None	Yes	No
Echinops	Africa, Eastern and Central Asia, Western Asia, Europe	Australia, North America	Yes	No	*Echinops ruthenicus* (NT)	No	Yes
Femeniasia	Northern Africa	None	No	No	NA	No	No
Galactites	Northern Africa, Southern Europe,	Central Europe, Northern Europe	No	No	NA	No	No
Hypacanthium	Northern Africa, Europe, Asia, Oceania	None	Yes	No	NA	No	Yes
Jurinea	Northern Africa, Asia, Europe	None	Yes	No	*Jurinea mollis subsp. dolomitica* (DD), *Jurinea mollis* (DD)	No	Yes
Lamyropsis	Central Asia, Southeastern Europe Western Asia (Turkey)	None	No	No	NA	No	No
Mantisalca	Southwestern Europe	None	No	No	NA	No	No
Notobasis	Mediterranean region, Middle East	Ethiopia, Great Britain, Australia	No	No	NA	No	No
Onopordum	Northern Africa, Central Asia, Western Asia, Europe	Australia, North America	Yes	No	None	No	Yes
Picnomon	Northern Africa, Central Asia, Western Asia, Southeastern Europe, Southwestern Europe	Australia, Northern Europe	No	No	NA	No	No

Table 2. *Cont.*

Subfamily Tribe *Genus*	Native Range	Introduced Range	Present in Southeastern Central Europe	Includes Species of Economic Interest (Crops, Ornamentals)	Red List Species in Hungary	Already Tested	Proposed For Risk Assessment for Southeastern Central Europe
Psephellus	Western Asia, Central Asia, Eastern Europe,	None	No	No	NA	No	No
Ptilostemon	Northern Africa, Western Asia, Eastern Europe, Southeastern Europe	Southwestern Europe	No	No	NA	No	No
Rhaponticoides	Northern Africa, Central Asia, Western Asia, Eastern Europe, Southeastern Europe, Southwestern Europe	None	Yes	No	NA	No	Yes
Rhaponticum (*syn. Leuzea*)	Russia, Western Asia, Central Asia, East Asia, Western Europe, Southern Europe, Eastern Europe, Southeastern Europe, Northern Africa	Northern Europe, North America, Australia, Southern Africa	Yes	No	NA	No	Yes
Saussurea	Asia, Australia, Europe, North America	None	Yes	No	NA	No	Yes
Serratula	Northern Africa, Asia, Europe	None	Yes	No	*Serratula lycopifolia* (EN), *Serratula radiata* (VU)	No	Yes
Silybum	Northern Africa, Asia, Europe	None	Yes	No	None	No	Yes
Staehelina	Northern Africa, Southern Europe, Western Europe	None	No	No	NA	No	No
Tyrimnus	Northern Africa, Southern Europe, Eastern Mediterranean	None	No	No	NA	No	No
Xeranthemum	Northern Africa, Central Asia, Western Asia, Europe	None	Yes	No	None	No	Yes

3.5. Plant Genera Relevant for Risk Assessments in Southeastern Central Europe

Within the tribes Cardueae, Astereae, Heliantheae, Inuleae, Coreopsideae, and Anthemideae potentially at risk, around 56 genera are found in southeastern Central Europe. Some 34 genera (61%) of those have not been tested so far (Table 2). These include the genera *Callistephus*, *Carduus*, *Carlina*, *Cirsium*, *Cnicus*, *Crupina*, *Echinops*, *Hypacanthium*, *Jurinea*, *Onopordum*, *Rhaponticoides*, *Rhaponticum* (syn. *Leuzea*), *Saussurea*, *Serratula*, *Silybum, and Xeranthemum* from the Cardueae tribe, and *Rudbeckia* from the Heliantheae tribe. They also include *Pulicaria and Telekia* from Inuleae, *Anacyclus*, *Anthemis*, *Chamaemelum*, *Chrysanthemum* (syn. *Dendranthema*), *Cotula*, *Glebionis*, *Ismelia*, *Leucanthemella*, *Leucanthemopsis,* and *Tanacetum* from Anthemideae, *Coreopsis* from Coreopsideae, and *Aster*, *Bellidiastrum*, *Galatella* (syn. *Crinitaria*), and *Tripolium* from the Astereae tribe. Selected species of those genera may be of interest for further testing.

4. Discussion

The leaf beetle *O. communa* is currently used as a biocontrol agent for the management of *A. artemisiifolia* in China, and it is also intended for wider use in Europe. This may involve targeted inoculative releases in areas where the beetle is not yet established, as well as repeated mass releases in regions where the beetle is established but climatic conditions may prevent the development of high population densities [12]. The use of *O. communa* has been promoted because (a) this agent effectively reduces *A. artemisiifolia* densities and airborne pollen concentration in East Asia, such as China, and in Europe, such as in northern Italy [42], and (b) because no major side effects have been observed to date under field conditions in regions where the beetle occurs or is used as a biological control agent. However, predicting potential risks associated with large-scale releases remains challenging for some European regions, despite extensive host-range testing (Table 1). For example, comprehensive risk assessments have been conducted for Western Europe [82] following the beetle detection in northern Italy. No major risks of this biological control agent were predicted from these studies, which supported a formal permit of release in France in 2025 [83]. However, comparable evaluations have not yet been carried out for some of the other European regions, particularly not for the hot-spot areas of *A. artemisiifolia* in Central Europe [42].

The evaluation of the fundamental host range of a classical biological control agent is one of the first steps in estimating potential risks or the safety of an agent to non-target species in a new environment where it may be released [84]. However, while laboratory tests are essential to assess the fundamental host range of a biological control agent, their predictive power for assessing non-target attacks in the area of release may be relatively limited. Not all species within the fundamental host range may actually be used under natural conditions [84,85]. Also, the complex aspects of climate matching are difficult to assess under laboratory conditions. Therefore, more relevant and predictive for the use of a biological control agent is its realized host range. This is the range of hosts a biological control agent may use under realistic field conditions, and is often narrower than the fundamental host range [1]. Predicting the realized host range should be made prior to the intentional release of a biological control agent through strict host-range testing. For *O. communa*, however, such testing was ongoing when the species was accidentally introduced in China and Europe. Consequently, post-introduction monitoring to assess non-target effects gained importance [86–88]. Yet, as stated above, our knowledge about plant species and communities potentially at risk is still limited for some European regions. Therefore, we reviewed results from existing host-specificity studies to identify knowledge gaps and to propose the next steps for additional risk-assessment research. We reviewed host specificity studies that had been conducted in regions where *O. communa* is native (North America), has been introduced (Europe, East Asia), was considered for introduction (Australia), or is currently considered for augmentation biological control (Europe). We identified 26 studies in the scientific literature containing reliable information. However, most of those studies were conducted under laboratory conditions (Table 1), with the limitations in predictive power as stated above [29].

Despite the abundance of data from those studies, this review revealed that it remains challenging to reliably predict the fundamental and realized host range of *O. communa* at the present time. This is due to insufficient data for some plant species in the existing studies, due to species and genera from large geographic regions not yet covered, and due to some methodological limitations [12]. Moreover, several of the reviewed studies focused on adult feeding bioassays without sufficiently assessing complete larval development, and adult survival and reproduction of *O. communa*. For example, field observations of different *O. communa* life stages on *Artemisia verlotiorum*, Anthemideae [57,59], warrant further investigations under controlled conditions, as they suggest that both the fundamental and realized host range of *O. communa* is not restricted to the Heliantheae and Inuleae. But *O. communa* may only successfully survive over many generations and build up populations on *Ambrosia* species in the Heliantheae, with the consensus that *A. artemisiifolia* is the main host.

Up to date, *O. communa* larvae were recorded feeding and surviving on various *Ambrosia* species, as well as on *H. annuus*, *H. tuberosus,* and some *Xanthium* species in the Heliantheae tribe, as well as on *D. graveolens* in the Inuleae tribe, and are also accepted under field conditions [33,40,73,89]. This does not, however, mean that *O. communa* can establish permanent populations on all species within the realized host range. Stage-specific life table analyses would offer a robust framework for such demographic assessments for predicting risks, as detailed by Chi et al. 2023 [90]. The population growth rate values of such life tables can then help to predict whether a species can sustain the *O. communa* population across several generations, thus potentially causing continuous damage, also in the absence of the target weed. *Helianthus annuus*, an economically important crop in Europe and in other parts of the world, has been a main subject of scientific debate regarding the risks of non-target effects by *O. communa* in the introduced range. It was the main reason why *O. communa* was rejected as a biological control agent of *A. artemisiifolia* in Australia. Life table analyses conducted by Dernovici et al. [33] revealed that *O. communa* is unlikely to establish permanent populations on *H. annuus* even in cases where *A. artemisiifolia* populations are successfully cleared [33,61]. They found a high egg and larval mortality on sunflower, as well as limited egg laying [33], which resulted in a population growth rate far below 1. Later, Jin et al. (2023) [60] confirmed this conclusion under natural field conditions. Interestingly, *O. communa* adults largely avoided *H. annuus* even when *A. artemisiifolia* was scarce, and would rather move to *X. sibiricum*, another non-target plant species of the Heliantheae tribe. In contrast, Rousset et al. (2024) [40] showed that the suitability of sunflower for the different *O. communa* life stages can differ among varieties. However, eggs and pupae found on most *H. annuus* varieties generally had relatively low weight compared to those developed on *A. artemisiifolia*, indicating that generational survival may be limited even on slightly more suitable *H. annus* varieties. Overall, based on the currently available studies mainly from Asia and Western Europe, the risk of *O. communa* to *H. annuus* appears low and restricted to damage by adult feeding in late summer and in autumn. Similar life table studies may be warranted in case complete development of *O. communa* may be found under laboratory and field conditions on species outside the Heliantheae tribe. In general, the challenge of balancing the benefits of biological control with non-target risks is well known. An example of potential difficulties is *Agasicles hygrophila* (Coleoptera: Chrysomelidae), which was introduced to China for *Alternanthera philoxeroides* control.

It was also recorded to feed slightly on the native non-target *Alternanthera sessilis.* Even though the damage was minor, the herbivory altered plant chemistry and volatile profiles, which negatively affected *Cassida piperata*, which also feeds on *A. sessilis* [91]. This shows that thorough experimentation is needed in risk assessments and that simple small-arena no-choice tests may not be sufficient.

Outside the Asteroidea subfamily, there are only a few records of some very limited attacks by adults of *O. communa*. For example, adult feeding was reported from *Centaurea nigrescens* from the Cardueae tribe of the Carduoideae subfamily [27,29]. Outside the Asteraceae family, reports are even scarcer. For example, Cardarelli et al. (2018) [62] reported some adult *O. communa* on non-Asteraceae species such as *Trifolium* spp. in the Fabaceae. However, no eggs or larval development were recorded on these species. These findings suggest that plant species in the Asteraceae family outside the Asteroideae and in other families are outside the fundamental host range of *O. communa*.

Following the centrifugal phylogenetic method of test plant selection **[37]**, there are, however, still numerous untested genera from tribes that might potentially be at risk, including species from some genera in the Anthemideae, Astereae, Cardueae, Coreopsideae, Heliantheae, and Inuleae tribes (Table 2). Only 3% of those genera have been tested so far, and can provide some information in terms of the safety of *O. communa* to non-target plants. As stated above, particularly species in some hot spots of *A. artemisiifolia* spread and pollen load in Europe have only been partially covered. For example, in the Pannonian basin in southeastern Central Europe, non-targets in about 34 plant genera may still need to be tested for understanding and concluding the risks or safety of this biocontrol agent in this region. Also, eleven economically or ecologically important species in those tribes may need to be included [92]. For example, the Inuleae tribe contains two species listed on the Red List in Hungary [81]. In summary, we propose to test at least some plant species in the so far untested genera potentially at risk, such as *Rudbeckia* spp. from the Heliantheae tribe, and *Pulicaria* spp. and *Telekia* spp. from the Inuleae tribe, present in southeastern Central Europe, including the Pannonian basin. Moreover, as host-range tests that assess the survival of *O. communa* life stages across generations are largely lacking, we propose that such life table studies be conducted for further plant species or varieties in the *Dittrichia*, *Inula*, and *Helianthus* genera. Once generational survival may be found, a choice test may follow, and ultimately, tests under natural field conditions may be conducted.

5. Conclusions

Extensive host specificity studies have been conducted with the biological control agent *O. communa* worldwide. Nevertheless, some gaps remain in predicting the safety of non-target plants in the subfamily Asteroideae from *O. communa*, such as from the southeastern Central European region, which is characterized by high *A. artemisiifolia* densities and pollen loads, and by high levels of ragweed sensitization rates among the human population. Future host specificity tests should address this critical gap to ensure a reliable assessment of the safety of *O. communa* as a biological control agent in those regions.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/agronomy15081771/s1, Table S1. Genera in Anthemideae, Astereae, Coreopsideae, Heliantheae, Inuleae tribes of the Asteroideae subfamily and Cardueae tribe of Carduoideae subfamily, all in the Asteraceae family that might potentially be part of the host range of *Ophraella communa* which is a major biocontrol agent for *Ambrosia artemisiifolia* (Heliantheae tribe) which is its main host. Tribes and genera shown that had been tested globally or not yet been tested. In total, 6 of 144 genera existing in the Heliantheae tribe have been tested (5%), 7 of 77 genera in the Inuleae tribe (9%), 4 of 119 in the Anthemideae tribe (3%) 3 of 85 Cardueae (3.5%), and 3 of 29 in Coreopsideae (10%). Genera names extracted from [46].

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