Giovanni Bosio* - Viola Massobrio* - Catarina Chersi* - Giovanni Scavarda* - Shawn Clark**

Spread of the ragweed leaf beetle, *Ophraella communa* LeSage, 1986 (Coleoptera Chrysomelidae), in Piedmont Region (northwestern Italy)

Riassunto: *Diffusione in Piemonte del crisomelide dell'ambrosia* Ophraella communa *LeSage, 1985* (*Coleoptera: Chrysomelidae*). *Ambrosia artemisiifolia* L., specie invasiva tra le più pericolose per la sua elevata produzione di polline allergenico e la cui introduzione in Europa risale al 19° secolo, non ha finora trovato specifici limitatori naturali nel nuovo ambiente. Nell'areale originario, il Nord America, molti insetti e funghi sono in grado di svilupparsi a carico di questa infestante, riducendone l'impatto sulla salute umana e sugli habitats naturali. Alcuni di questi organismi, specifici o oligofagi su *A. artemisiifolia*, sono considerati molto promettenti per il controllo biologico di questa asteracea e in alcuni casi sono già stati introdotti in altri continenti. Tra queste specie *Ophraella communa* LeSage (Coleoptera: Chrysomelidae) è stata trovata su piante di ambrosia all'inizio di agosto 2013 nei pressi di un vivaio a Galliate (Provincia di Novara). Nel periodo tra agosto e novembre sono stati condotti sopralluoghi in varie province piemontesi per documentare la diffusione di questo galerucino di recente introduzione. Nel presente lavoro sono riportati dati riguardanti morfologia, ciclo biologico, diffusione, piante ospiti e nemici naturali nel nuovo ambiente. Sono inoltre discusse le prospettive per un possibile controllo biologico dell'ambrosia in Europa a seguito dell'introduzione di questo insetto nordamericano.

Abstract: Common ragweed, *Ambrosia artemisiifolia* L., one of the most dangerous invasive species for its high allergenic pollen production, has been spreading in Europe since the 19th century but has not until now recruited any effective natural enemy. In its native range, North America, many insects and fungi are recorded feeding or developing on this weed, reducing common ragweed impact on human health and habitats. Some of these organisms, specific or oligophagous on *A. artemisiifolia*, are considered promising agents for the biological control of this weed, and in some cases they have already been introduced in other continents. Among these species, the leaf beetle *Ophraella communa* LeSage (Coleoptera: Chrysomelidae) was found at the beginning of August 2013 attacking common ragweed near a nursery in Galliate (Novara Province - Piedmont Region). Field surveys were carried out from August to November in various Piedmont counties to document the spread of this recently introduced galerucine species. Data are reported regarding the leaf beetle's morphology, biological cycle, spread, hosts and natural enemies in the new range. Prospects for the biological control of common ragweed in Europe are also discussed.

Key words: *Ambrosia artemisiifolia*, *Arma custos*, Biological control, Common ragweed, Invasive weed, Leaf beetle, *Ophraella communa*, Predaceous stinkbug.

Introduction

Common ragweed, *Ambrosia artemisiifolia* L. (Asteraceae: Helianthae), an annual weed native to North America, has spread in the last centuries to other continents and is now naturalized in many areas of Asia, Australia and Europe. Heavily colonized areas in Europe include the French Rhône Valley, northern Italy, Hungary, some countries of the Balkan Peninsula (Bulgaria, Croatia, Serbia, etc.), as well as Ukraine and southern Russia (EFSA, 2010).

Following Gerber *et al*. (2011), the first records in western Europe date back to the 19th century, while in eastern Europe they date to 1900. In Italy, naturalized *A. artemisiifolia* was observed for the first time in Piedmont and Liguria in 1902 and now is distributed in many other regions. The exotic weed has been cultivated at the Botanic Garden of Turin City since 1772, but its spread is probably due to accidental introductions through agricultural commodities (seeds, animal feeds) from North America. Now in Piedmont, ragweed is common in all the provinces, but its populations are larger in the eastern counties bordering Lombardy Region (AA.VV., 2008; Bouvet *et al.,* 2013).

Common ragweed is a pioneer species that prefers habitats such as roadsides, railway ballast, construction sites, and disturbed or riparian areas where it displaces the native flora (Figs. 1, 2). Common ragweed is also a weed of summer crops (*e.g.,* soybean, maize, sunflower), usually in dried soils, from whence it can spread to barley and wheat stubbles after harvest

*Giovanni Bosio, Viola Massobrio, Catarina Chersi, Giovanni Scavarda, Phytosanitary Service, Piedmont Region, Environment Park, Pal. A2, 10144 Turin, Italy. E-mail: giovanni.bosio@regione.piemonte.it; viola.massobrio@regione.piemonte.it; catarina.chersi@regione.piemonte.it; giovanni.scavarda@regione.piemonte.it

**Shawn Clark, Monte L. Bean Life Science Museum, Brigham Young University, Provo (UT), USA. E-mail: shawn_clark@byu.edu

(Fig. 3). Furthermore, this plant is well known worldwide for its huge allergenic characteristics that seriously affect human health. Male flowers produce a large quantity of wind-dispersed pollen that can cause hay fever, rhino-conjunctivitis and asthma, or that can induce skin irritation in sensitive people. *Ambrosia artemisiifolia* may cross-sensitize patients to other allergens, including food allergens (EFSA, 2010).

The European and Mediterranean Plant Protection Organization (EPPO) has included *A. artemisiifolia* in the list of invasive alien species and recommends the adoption of specific measures of control in the infested regions to reduce the damages to agriculture, the environment and public health. Presently in Europe, common ragweed has recruited only a small number of natural enemies, such as polyphagous insects or pathogenic fungi, none of them being effective. Therefore, control strategies are based on manual eradication, mowing interventions, flame weeding or use of chemical herbicides (*e.g.,* glyphosate, flazasulfuron) in non-agricultural areas, while herbicides such as sulcotrione, mesotrione, nicosulfuron and dicamba can be applied in corn crops, bentazone and metribuzin in soybean and imazamox in sunflower (only for tolerant varieties) (AA.VV., 2013).

Unfortunately, in the U.S.A. and Canada, *A. artemisiifolia* has developed resistance to herbicides of the acetolactate synthase inhibitors (ALS) group (*e.g*., flazasulfuron and nicosulfuron) on soybean and corn; moreover, starting in 2004, many cases of resistance to glyphosate were observed in the U.S.A. on soybean (HRAC, 2013). In its original range, this weed has some control factors, such as the leaf beetles *Ophraella communa* LeSage, *O. slobodkini* Futuyma and *Zygogramma suturalis* (Fabricius) (Coleoptera: Chrysomelidae), and the tip-galling moth *Epiblema strenuana* Walker (Lepidoptera: Tortricidae). These insects have been reputed as potential agents for the biological control of *A. artemisiifolia* and some of them have already been introduced in some Eurasian countries and in Australia, with contradictory results (Gerber *et al.*, 2011).

The first of the insects mentioned above, the leaf beetle *O. communa*, which is considered the most promising biological control agent of common ragweed (Kiss, 2007), was detected at the beginning of August 2013 on *A. artemisiifolia* plants in some localities of northeastern Piedmont (Figs. 4, 5). About one month in advance, the ragweed leaf beetle was found in neigh-

Fig. 1. *Ambrosia artemisiifolia* along roadside**.**

Fig. 2. *Ambrosia artemisiifolia* in a disturbed area.

Fig. 3. Soybean crop infested by common ragweed.

boring Ticino Region in south Switzerland (Müller-Schärer *et al*., 2014) and later in the bordering Lombardy and Emilia-Romagna Regions; so, the first report of the introduction of this galerucine in Italy and Europe was published in September (Boriani *et al.,* 2013).

Materials and methods

After the detection of the leaf beetle in the municipality of Galliate (Novara Province), northeastern Piedmont, specimens were sent to the Monte L. Bean Life Science Museum - Brigham Young University (Provo-Utah), where they were confirmed to be *O. communa*. In the following weeks, from August to November, surveys were carried out in various counties of Piedmont Region to investigate leaf beetle spread, intensity of the attacks, damage to common ragweed, alternative host plants and presence of any natural enemies. Geographic coordinates (UTM-WGS84) and brief descriptions of the monitored sites were also recorded. Levels of damage inflicted by *O. communa* attacks to *A. artemisiifolia* plants were estimated in the different sites on the basis of the following scale:
+++++: high defoliation, some dried and killed plants
++++: defoliation, plants partially dried
+++: many leaves with erosions
++: erosions on some leaves
+: light erosions on few leaves

Further observations in the field and laboratory were conducted to define morphologic and biologic features of this recently introduced species. Ten males and ten females, collected in September, were examined under a Leica M205C stereomicroscope and using Leica Application Suite (LAS) V 4.2 measurement module to estimate the following data: body length (from head to elytral posterior margin) and width, pronotal width, elytral length.

Results

Short taxonomic notes. The genus *Ophraella* Wilcox (Chrysomelidae: Galerucinae, tribe Galerucini) is strictly native to North America, with all species feeding on plants of the family Asteraceae (Compositae), except one reported on Lythraceae (Jolivet & Hawkeswood, 1995). Wilcox (1965) segregated it from *Galerucella* Crotch, a genus that is rather distantly related but in which several species of *Ophraella* were formerly placed. *Ophraella* was revised by LeSage (1986), who recognized 13 species, describing seven as new and renaming two others. In particular he described *O. communa*, distinguishing it from *O. notulata* (Fabricius). Futuyma (1990, 1991) synonymized *O. macrovittata* LeSage, 1986 with *O. sexvittata* (LeConte, 1865), described two additional new species, *O. artemisiae* and *O. slobodkini*, and further investigated the taxonomic status and host affiliation of each of the known species. Finally Riley *et al.* (2003), cataloguing the leaf beetles of America north of Mexico, listed fourteen species of the genus *Ophraella*.

Morphologic features. According to LeSage (1986), *O. communa* can easily be distinguished from its North American congeners by the moderately dense pubescence of the elytra and by the elytral pattern, with the subsutural and submarginal vittae usually joined together at the apex, with an incomplete discal vitta most evident in the distal half, and with a supple-

Fig. 4. *Ophraella communa* adults on common ragweed.

Fig. 5. *Ophraella communa* adults on common ragweed.

mentary vitta (between the subsutural and discal vittae) usually extending from the elytral base to about mid-length (Fig. 6). In darkly marked specimens, the subsutural and supplementary vittae may be confluent. In pale specimens from western North America, the vittae are faint or nearly absent. The elytral ground color is yellow or pale brown. The vittae are normally black or brown, but they may be light brown in paler specimens. *Ophraella communa* adults collected in Piedmont usually show light brown elytra and black vittae. Males are rather difficult to distinguish from females, but there are slight differences in the terminal abdominal ventrite, and males have a small spur at the apex of the mesotibia, although this is sometimes easily visible only upon removal of the leg (Fig. 7).

In Europe, *Ophraella* is most similar to *Monoxia* LeConte, another North American genus that has recently been discovered in Italy (Clark *et al.*, 2014). However, adults of the adventive species of *Monoxia* are only 2.4-3.7 mm long, the elytral markings (when present) are mostly in the form of isolated spots rather than vittae, many specimens have a deflexed pygidium, and the females have simple rather than bifid tarsal claws. With regards to the native European species, *Ophraella* is most likely to be confused with *Pyrrhalta* Joannis, *Xanthogaleruca* Laboissière or *Galerucella* (including subgenus *Neogalerucella* Chûjô). However, the elytra in those genera are rather shortly pubescent, in contrast to the somewhat shaggy elytra of *O. communa* that have longer pubescence, usually including many more or less erect setae. Moreover, the elytral patterns of the European species are unlike that described above for *O. communa*.

Size of specimens from Piedmont. Male: body length 4.01-4.59 mm (4.33 mm average); body width 1.97-2.36 mm (2.11 mm average); pronotal width 1.25-1.59 mm (1.40 mm average); elytral length 2.84-3.30 mm (3.12 mm average). Female: body length 4.36-5.07 mm (4.71 mm average); body width 2.03-2.57 mm (2.39 mm average); pronotal width 1.36-1.60 mm (1.53 mm average); elytral length 3.29-3.92 mm (3.61 mm average) (Fig. 8).

Biological cycle. In North America, *O. communa* has one to three generations each year. Females lay eggs in clusters on the lower surface of leaves. Eggs are pyriform, with hexagonal microsculpture, and turn quickly from yellow to orange (Fig. 9). Hatching occurs after five days and three larval instars develop in about 9-12 days, before pupation (Welch, 1978) (Figs. 10, 11). Mature larvae, 6-7 mm long (Fig. 12), spin loosely woven cocoons on stems and leaves of the host plant (Fig. 13). Adult emergence takes place after 3.4-4.4 days

Fig. 6. *Ophraella communa* elytral pattern.

Fig. 7. Spur at mesotibial apex of male.

(LeSage, 1986). In Tsukuba District (Japan), where climatic conditions are partially similar to those of Po Valley (Italy), overwintering adults mate in April and females start to lay eggs in late April to May. The first and second generation adults occur respectively in June and July, when all stages are present due to the overlapping of generations. The third generation develops after August, with some individuals entering diapause, while others continue to reproduce, giving rise to a fourth generation (K. Tanaka, pers. comm.). Adults often overwinter in the dry, rolled leaves of *Xanthium canadense* Mill. and *Ambrosia trifida* L., after feeding and reproducing on *A. artemisiifolia* and *A. trifida* (Watanabe & Hirai, 2004). One generation (from egg to adult) develops in about 25 days in summer.

DISTRIBUTION AND HOST RANGE. The native range of *O. communa* is the Nearctic Region, where populations are present from southern Canada to Mexico. As its preferred host, *A. artemisiifolia*, has spread to other continents as an invasive weed, this beetle has also been expanding its range in the last twenty years, reaching Japan (1996), Taiwan (1996), Korea (2000) and China (2001). Throughout eastern North America,

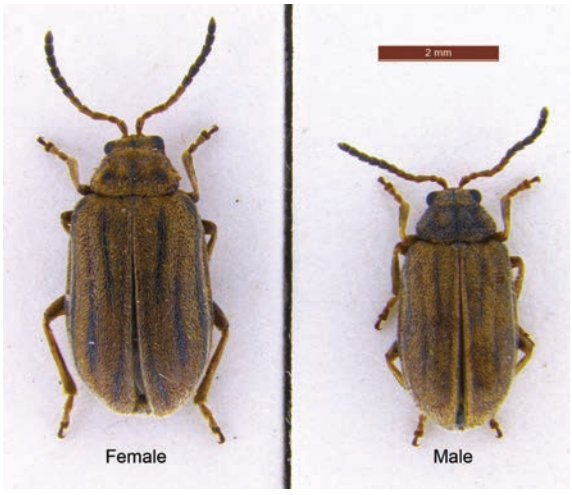

Fig. 8. *Ophraella communa*: female and male.

Fig. 10. Adult and first larval instar (on the right side).

Fig. 9. Eggs.

Fig. 11. Second larval instar.

O. communa is associated almost exclusively with *A. artemisiifolia*, while in western states it's reported also on *Ambrosia psilostachya* DC., *Iva axillaris* Pursh and *Xanthium strumarium* L., all in the tribe Heliantheae, subtribe Ambrosiinae. Future taxonomic study of *Ophraella* may prove that some of the western associations actually apply to other beetle species. Specimens were found in Texas on *Helianthus ciliaris* DC. and in Missouri on *Rabitida pinnata* (Vent.) Barnhart, both plants belonging to subtribe Helianthinae (Futuyma, 1990). In Japan, the ragweed beetle rapidly spread after the first appearance in Chiba Prefecture and Tokyo Bay in the summer 1996. At the end of 2000, it was reported in 37 of the 45 prefectures (Moriya & Shiyake, 2001). *Ambrosia artemisiifolia* is the most suitable host plant. After its exploitation, the beetle shifts to *A. trifida*, *X. strumarium*, *X. canadense* and *X. italicum* Moretti (Yamazaki *et al.,* 2000). In mainland China, *O. communa* was first discovered in Nanjing (eastern China) in 2001; since then, it rapidly spread to eastern and central China, significantly suppressing the ragweed population in many areas (Zhou *et al.*, 2010) and occasionally attacking *A. trifida* and *Xanthium sibiricum* Patrin.

Ophraella communa spread and hosts in Piedmont. Thanks to a nursery owner's information, at the beginning of August, 2013, various *O. communa* instars were observed actively feeding on *A. artemisiifolia* plants growing in and around a little ornamental plant nursery near the Ticino River. Subsequent surveys revealed a large diffusion of the beetles in Novara County, where many ragweed patches hosted large numbers of eggs, larvae, adults and cocoons of this exotic species. Presence of the beetle was also detected in other neighboring provinces, but usually at a lower level (Tab. 1).

Results of field surveys showed that the ragweed leaf beetle had already spread throughout an area of about 4100 square kilometers in Piedmont (Fig. 14). During summer inspections, the beetle was observed feeding exclusively on common ragweed. Sometimes, adult beetles were found on other potential hosts, *e.g.*, *X. strumarium*, *Helianthus tuberosus* L. and *Erigeron canadensis* L., when these plants grew mixed with *A. artemisiifolia*, but feeding was not observed. In one site (Proh, Briona, Novara County) at the end of September, some *O. communa* adults were found feeding on young leaves and stipules of *H. tuberosus*, after a huge exploitation of the neighboring ragweed plants about two meters tall (Fig. 15). Sunflower (*Helianthus annuus* L.) crops in Alessandria Province (southeastern Piedmont) are sometimes infested by common ragweed along the borders (Fig. 16). A survey in the first half of October revealed that *A. artemisiifolia* was infested by the leaf beetle and tall plants (about 200 cm.) were partially defoliated. Nevertheless, no *O.*

Fig. 12. Third larval instar.

Fig. 13. Cocoons.

Tab. 1. Piedmont: sites with *O. communa* infestation (see Materials and Methods section for explanation of damage rating).

Date (2013)	Province	Town	X	Y	Altitude (m.)	Habitat	Damage
08-07	Novara	Galliate	479912	5036837	157	Unused field	+ + + + +
08-14	Novara	Galliate	474999	5037399	146	Roadside	+ + + + +
08-14	Novara	Cameri	473589	5040436	135	Roadside	+ + + + +
08-14	Novara	Bellinzago Nov.se	472410	5045769	182	Roadside	+ + + + +
08-14	Novara	Marano Ticino	471233	5053729	118	Roadside	+ + + + +
09-04	Novara	Borgomanero	460070	5057800	279	Roadside	+ + + +
09-04	Novara	Cureggio	458025	5059105	304	Roadside	+ + + +
09-04	Novara	Fontaneto d'Ag.	458735	5056849	281	Roadside	+ + + +
09-04	Novara	Fontaneto d'Ag.	461646	5053173	255	Roadside	+ + + +
09-04	Novara	Cavaglio d'Ag.	461903	5051828	242	Roadside	+ +
09-04	Novara	Cavaglietto	460877	5051391	245	Roadside	+ +
09-04	Novara	Barengo	461327	5049562	227	Roadside	+ +
09-04	Novara	Barengo	462368	5045285	204	Roadside	+ +
09-04	Novara	Briona	461705	5042417	186	Riverbank	+ + +
09-04	Novara	Nibbia	466477	5037996	164	Roadside	+ + + +
09-05	Vercelli	Trino Vercellese	425442	5004804	130	Roadside	+ +
09-05	Vercelli	Saluggia	445140	5003954	194	Roadside	+ +
09-10	Novara	Romagnano Sesia	453054	5052560	268	Roadside	+ + +
09-11	Biella	Massazza	438106	5035883	197	Roadside	++
09-11	Biella	Massazza	433377	5038612	231	Roadside	+ + +
09-11	Biella	Verrone	429866	5041271	304	Roadside	+ + +
09-11	Biella	Biella	427868	5044277	306	Roadside	+ + +
09-11	Biella	Sandigliano	428430	5041614	317	Crop field	+ + +
09-11	Biella	Sandigliano	428382	5039769	309	Roadside	+ + +
09-11	Biella	Vergnasco	429241	5036322	249	Roadside	+ +
09-11	Biella	Dorzano	430397	5030933	243	Roadside	+ +
09-11	Biella	Cavaglià	429809	5028480	245	Roadside	+ +
09-11	Biella	Cavaglià	428781	5027428	197	Roadside	+ +
09-11	Vercelli	Alice Castello	427982	5025224	250	Roadside	+ +
09-11	Vercelli	Borgo d'Ale	426961	5023544	242	Roadside	+ +
09-11	Vercelli	Cigliano	423397	5016900	219	Roadside	+ +
09-11	Torino	Rondissone	418157	5010595	210	Parking area	+ +
09-11	Torino	Chivasso	416868	5007851	195	Roadside	+ +
09-11	Torino	Brandizzo	410667	5004790	194	Roadside	+ +
09-11	Torino	Settimo Torinese	403705	4998188	143	Roadside	+ +
09-11	Torino	Settimo Torinese	400648	4997073	208	Roadside	+ +
09-11	Torino	Torino	398384	4995113	230	Roadside	+
09-25	Novara	Trecate	461705	5042417	135	Roadside	+ + + + +
09-29	Torino	Chieri	407740	4983392	186	Roadside	+ +
10-09	Vercelli	Santhià	433170	5025581	205	Roadside	+ + +
10-09	Vercelli	San Germano V.	442221	5021957	157	River bank	+ + +
10-09	Vercelli	Vercelli	452024	5019344	123	Roadside	+ + +
10-09	Vercelli	Vercelli	457253	5015609	122	Abandoned area	+ + +
10-09	Vercelli	Stroppiana	457644	5006504	115	Roadside	+ + +

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Date (2013)	Province	Town	X	Y	Altitude (m.)	Habitat	Damage
10-09	Alessandria	Occimiano	459914	4991282	105	Roadside	+ + +
10-09	Alessandria	Alessandria	465670	4979864	116	Roadside	+ + +
10-09	Alessandria	Quargnento	462525	4979412	111	Crop field	+ + +
10-09	Alessandria	Quargnento	462081	4978964	87	Crop field	+ + +
10-09	Alessandria	Solero	461777	4974411	93	Parking area	+ +
10-09	Alessandria	Alessandria	467885	4974493	60	Roadside	+ +
10-09	Alessandria	Alessandria	471708	4972993	45	Roadside	+ +
10-09	Alessandria	Litta Parodi	476213	4968829	96	Roadside	+ +
10-09	Alessandria	Tortona	487315	4972306	115	Roadside	+ +
10-09	Alessandria	Sale	485450	4980711	65	Roadside	+ +
10-09	Alessandria	Sale	484915	4981533	77	Abandoned area	+ + +
10-09	Alessandria	Piovera	479214	4977586	72	Roadside	+ +
10-09	Torino	Chieri	405455	4987048	342	Roadside	+ +
10-14	V.C.O.	Baveno	459802	5086892	223	Roadside	+ +
10-14	V.C.O.	Cuzzago	451521	5093863	213	Roadside	+ +
10-14	V.C.O.	Anzola d'Ossola	449949	5093202	217	Roadside	+ +
10-14	Torino	Caluso	414672	5017249	315	Roadside	+ +
10-25	Torino	Torino	395472	4994016	204	Roundabout	+
10-29	Torino	Torino	394133	4994427	253	Roundabout	+

communa adults, larvae or eggs were detected on sunflower plants. Damage caused to common ragweed by adults and larvae was massive in various sites of Novara Province, where in August and September many host plants were completely defoliated and reduced to brown stumps, without leaves or flowers (Figs. 17-19). Various instars of the beetle were usually present on the host in this area, probably because of an overlapping of generations. On a single medium sized plant (50-60 cm tall), about 250 adults were counted at the end of August. The feeding activity, resulting in full and intense leaf skeletonizing, stops the plants' growth and induces them to dry. Strong beetle infestations can kill the ragweed in summer; so, adults have to fly to find new, non-infested plants in other areas. In this case, the subsequent attacks usually do not kill the plants but can stop blossom and pollen production, inducing also desiccation of the anthers.

Sometimes, fungi (identified as *Fusarium* sp.) attack injured plants, as already reported in other countries, bringing about death. Leaving Novara Province to western areas of Piedmont, damage to the host plants was usually lighter due to a reduced concentration of the beetles. Around mid-September, *O. communa* was also detected in Turin City, on patches of common ragweed growing in a traffic roundabout and along the sidewalks of a street in the north of the city (Fig. 20). On these plants, feeding damage occurred only on basal leaves and cocoons were the prevalent stage, indicating that probably only a few adults were present about one month before and that only one generation had developed at that time. At the beginning of October, adults, probably preparing to overwinter, were the most abundant stage on the plants. After mid-September, no eggs were found on the infested plants, confirming that adult females enter diapause when photoperiod shifts from long-days to short-days (Zhu *et al.*, 2012). However, in the last week of October, thanks to a mild fall, young common ragweed plants were found recently infested by the leaf beetle in other sites of Turin City. These plants, regrown along roadsides after late summer rainfalls, 20-50 cm tall and beginning to blossom, showed light leaf damage and hosted a few darker *O. communa*

adults (Fig. 21). This means that, although short photoperiod induces reproductive diapause and reduces beetles' flight activity, mostly in the last generation (Tanaka & Yamanaka, 2009), some specimens continue to spread in full autumn. The intensity of the attacks and the beetle population sizes in the different areas, considering also the actual spread reported in Italy and Switzerland (Ticino Region) (Müller-Schärer *et al*., 2014), the high reproductive rate, about 400 eggs for female (Zhu *et al.*, 2012), and the speed of range expansion estimated to be over 100 km/yr. in the first period of spread in Japan (Tanaka, 2009; Yamamura *et al.,* 2007), suggest a recent (about two years) and accidental introduction through international flights at the Milano Malpensa Airport, not far from the eastern border of Piedmont.

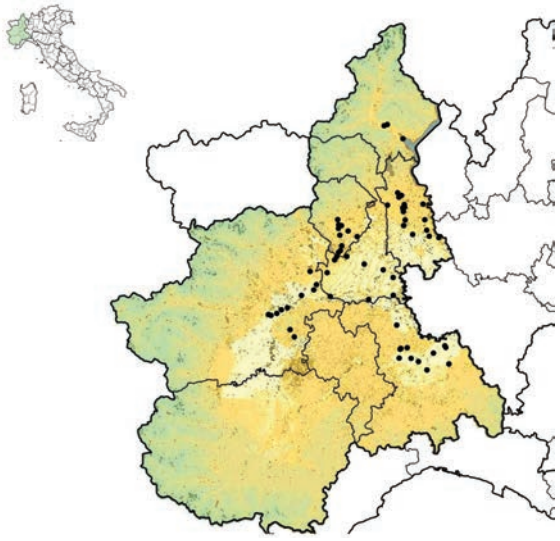

Fig. 14. Georeferenced spread of *O. communa* in Piedmont.

NATURAL ENEMIES OF THE RAGWEED LEAF BEETLE IN THE NEW RANGE. In late summer, the first consistent presence of a predator species, the stinkbug *Arma custos* (F.) (Heteroptera: Pentatomidae), was detected in the area of Novara Province where *A. artemisiifolia* suffers high *O. communa* attacks (Fig. 22). This Palaearctic species, spread from Europe and North Africa to China and Japan, belongs to the subfamily Asopinae that includes zoophagous stinkbugs. In Italy, nine species are recorded in this subfamily, belonging to seven different genera and all feeding on larvae of Lepidoptera or Coleoptera (especially Chrysomelidae) (Dioli, 1985). One distinctive character of asopine species is the incrassate rostrum, well adapted to prey on other insects (Thomas, 1994). *Arma custos* is usually described as a nonspecific predator, attacking larval instars of leaf-feeding Lepidoptera, Coleoptera (Chrysomelidae) and Hymenoptera (Tenthredinidae). In Russia, it develops one generation per year and is considered a useful agent for the biological control of *Leptinotarsa decemlineata* (Say).

In France, it's the main control factor of *Chrysomela* populations on poplar, while in China this stinkbug preys on about forty agricultural and forest pests, providing very effective control against another chrysomelid species, *Ambrostoma quadriimpressum* Motsch. (De Clercq, 2000). *Arma custos* is widely distributed in Japan, where it has already been observed to prey on *O. communa* adults (K. Tanaka, pers. comm.). In Piedmont, nymphs and adults were found actively feeding on the exotic leaf beetle, inserting the rostrum in the adults' bodies to suck the hemolymph (Fig. 23).

Fig. 15. Adults feeding on *Helianthus tuberosus.*

In various sites, medium sized ragweed plants often hosted 4-5 *A. custos* adults. *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae) adults and larvae were also detected on common ragweed infested by the leaf beetle. This ladybird beetle was already reported in Japan as a predator of *O. communa* eggs and first instars (Moriya *et al.*, 2002), as were unidentified adult coccinellids in North America (Futuyma, 1990).

Discussion

Ophraella communa spread may raise the question of whether we are facing a useful agent of *A. artemisiifolia* biological control in Europe or a risk for other asteraceous plants (*e.g.*, sunflower crop). Considering that the beetle has already spread throughout a large area between Piedmont and Lombardy, any attempt at eradication of this exotic insect is not feasible and, above all, probably not desirable. The possibility that *O. communa* might control common ragweed in some European countries (*e.g.*, Hungary) or areas (*e.g.,* Rhône and Po Valleys) where this plant constitutes a serious threat to human health, agriculture and landscape management, sounds very interesting, especially in consideration of the lack in Europe of any effective natural enemy of this noxious weed and the expected increasing spread of common ragweed due to climate change.

Although in the plant's native range more than 25 fungal pathogens and more than 200 species of arthropods are known to damage *A. artemisiifolia*, until now in Europe only a small number of pathogenic fungi or polyphagous insects, usually non-effective, have been detected (Kiss, 2007). Moreover, releases of North American insects feeding on common ragweed into other countries, such as the release of the monophagous chrysomelid *Z. suturalis* in the former Soviet Union, Croatia, China and Australia, were not successful. In the last decades, hopes of finding an effective biological control agent against *A. artemisiifolia* have been focused on *O. communa*. This leaf beetle is the most widespread enemy of common ragweed in North America, and it normally has a higher population density than that of *Z. suturalis* (Kiss, 2007). It was not authorized for introduction in Australia due to the laboratory trials of Palmer and Goeden (1991) that suggested possible damage to sunflower (Asteraceae). Even so, in North America this beetle has never been recorded as a pest of *H. annuus*. Subsequent research in Canada determined that it's

Fig. 16. Sunflower infested by common ragweed.

Fig. 17. Common ragweed: massive defoliation by *O. communa.*

quite improbable that *O. communa* could significantly damage sunflower plants in the open field. The leaf beetle adults prefer common ragweed for feeding and egg-laying, and fifty percent of young larvae feeding on sunflower die.

In a theoretic simulation of the development on the two different hosts, an increase of 208 times was estimated in the beetle population feeding on *A. artemisiifolia* compared to a 4.2 times decrease in the population feeding on sunflower (Dernovici *et al.*, 2006). In Japan too, *O. communa* has been reported feeding on ornamental dwarf sunflower cultivars as a secondary host, after exploitation of common ragweed (K. Tanaka, pers. comm.). Nevertheless, it was thought that it's unlikely the insects can severely harm sunflower (Emura, 2000). Recent investigations in China assess a low risk of damage to sunflower crops by the accidentally introduced leaf beetle; so, in recent years a mass-rearing programme was established to use *O. communa* for the biological control of invasive common ragweed (Zhou *et al*., 2011). On the other hand, the fact that the chrysomelid extensively exploits *A. trifida* in Japan, while it's not recorded to feed on this host in its native region, suggests the possibility of host changing in the new introduced range (Fukano & Doi, 2013). The spread of the ragweed leaf beetle into Europe is not surprising, considering that in the last twenty years this species was detected, out of its native range, in many Asiatic countries and its introduction was usually reputed accidental. Also, the spread of this beetle in Italy and Switzerland, in an area not far from the Milano Malpensa International Airport, implies a fortuitous introduction, reminiscent of another famous Nearctic galerucine, *Diabrotica virgifera virgifera* LeConte, the corn root beetle. Probably, the large diffusion of the preferred host plant in many countries and some specific features of this insect, such as small size, adept flying ability and high reproductive rate, enhance the chance to spread to other countries. It's very likely that in a few years *O. communa* could invade other European states, improving the control strategies of *A. artemisiifolia* aimed to reduce the impact of the invasive weed on human health, agriculture and natural habitats. The real effectiveness of this leaf beetle as a biological control agent will be strongly influenced by the recruitment of natural enemies in the new range of expansion. The consistent presence of the zoophagous stinkbug *A. custos* demonstrates that other predators could rapidly shift to exploit this new source of food. So, the scenario we could expect in the next years is the development of

Fig. 18. Common ragweed: massive defoliation by *O. communa.*

Fig. 19. Common ragweed killed by *Ophraella communa* attack.

Fig. 20. Common ragweed on sidewalks in Turin City.

new trophic interactions among the invasive common ragweed, the oligophagous herbivore *O. communa* from the same North American native range, and the natural enemies that will adapt and feed on the recently introduced leaf beetle. Further research is needed in the next years to investigate all these population dynamics and to assess the effective role of this beetle in the management of invasive common ragweed.

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Fig. 22. *Arma custos* adult preying a leaf beetle.

Fig. 21. Adult's dark feature in full autumn.

Fig. 23. *Arma custos* nymph.

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