

# First record of the invasive sawfly *Aproceros leucopoda* infesting elms in Italy

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## Abstract

The occurrence of an East Asian sawfly, *Aproceros leucopoda* Takeuchi (Hymenoptera Argidae), in Italy is reported here for the first time. In 2009, this invasive species was observed in five sites in the Friuli Venezia Giulia region (north-eastern Italy) along the Alpe-Adria A23 motorway. A survey carried out in 2010 has enabled verification that the sawfly has spread across an area of more than 1,200 km<sup>2</sup> (68 infested sites out of 132 investigated), covering part of Friuli Venezia Giulia (Udine and Pordenone districts) and the neighbouring Veneto region (Treviso district). Only female adults were observed, suggesting that the species reproduces parthenogenetically. The species is multivoltine and most likely produces at least four generations per year in lowlands of north-eastern Italy. The larvae have severely defoliated different elm species, mainly field elm (*Ulmus minor* Mill.) and Siberian elm (*Ulmus pumila* L.). Also, wych elm (*Ulmus glabra* Huds.), monitored at a mountain site, has been attacked by the sawfly. The repeated defoliations could dramatically aggravate the phytosanitary state of elms already stressed from Dutch elm disease, which is transmitted by bark beetles, and elm yellows transmitted by leafhoppers.

**Key words:** Hymenoptera, Argidae, insect pest, alien species, geographical distribution, *Ulmus*.

## Introduction

The increasingly intense and rapid movement of people and trade materials among continents has allowed the accidental arrival of many alien species, especially insects. Some of these species have become invasive, causing severe damage (Pimentel, 2002). Regarding Italy, established exotic insects have been listed and discussed elsewhere (Pellizzari and Dalla Montà, 1997; Jucker *et al.*, 2009).

In 2009, elm trees growing in some parking areas along the Alpe-Adria A23 motorway of the Friuli Venezia Giulia region (north-eastern Italy) were severely defoliated during the vegetative season (figure 1a). Visual inspection of the sites allowed the observation of numerous flying adult insects on elm twigs, and feeding traces, larvae and cocoons on elm leaves (figure 1b, 1c, 1d). The pest was identified as an Argid sawfly species (belonging to the subfamily Sterictiphorinae) not included in the keys of European Symphyta. Only recently it was possible to identify the species as *Aproceros leucopoda* Takeuchi (Hymenoptera Argidae), which has an Asiatic origin. "Zigzag elm sawfly" has been proposed as its common name due to the characteristic pattern that the young feeding larvae produce on leaves (Vetek *et al.*, 2010). The sawfly has already been observed in Austria, Hungary, Poland, Romania, Slovakia and Ukraine (Blank *et al.*, 2010), in Serbia (Hirka, 2010) and most likely in Moldova (Timus *et al.*, 2008), where it caused serious defoliations of spontaneous and ornamental elms.

Based on observations from Hokkaido Island in northern Japan (Blank *et al.*, 2010), *A. leucopoda* was reported as having parthenogenetic reproduction, up to four generations per year, and a nymphal over-wintering stage. Its rapid reproduction and the production of simplified cocoons support its ability to develop several generations per year and numerous offspring.

Females lay eggs along the leaf margin. After six larval instars, onymphs make cocoons and pupate. In Japan, adults were found from mid May to early September and late instar larvae were observed from late June to late September. In Hungary, adults occur earlier than in Hokkaido, from mid April until early September and late instar larvae are found from mid May (Blank *et al.*, 2010).

The aims of the present study are to provide information on the current geographical distribution of *A. leucopoda* in an area of north-eastern Italy and to collect the first data on its biology for this country.

## Materials and methods

### Species identification

For the identification of *A. leucopoda*, the key of Blank *et al.* (2010) has been used, which includes detailed descriptions of larvae, adults and the characteristic damage caused by the feeding larvae on elm leaves.

For the identification of elm species the key of Pignatti (1982) has been used.

### Species distribution

In 2009 (July-August), observations were carried out in the Friuli Venezia Giulia region in several parking areas along the Alpe-Adria A23 motorway between Udine and Tarvisio (Austrian border) (figure 2), after noting the presence of elms infested by *A. leucopoda* in one of them.

In 2010, after observing that the species was present in the sites infested in 2009 as well as in additional localities, 132 sites with elms of different species were sampled. The sites were located in four districts (Udine UD, Pordenone PN, Gorizia GO, and Trieste TS) of the Friuli Venezia Giulia region and two districts (Treviso TV, and Venice VE) of the neighbouring Veneto region. The



**Figure 1.** Elm trees completely defoliated by *A. leucopoda* larvae (parking area “Cormor Est”, Treppo Grande, Udine), summer 2009 (a); elm leaf with the zigzag feeding trace of a young *A. leucopoda* larva (b); larva of *A. leucopoda* feeding on an elm leaf (c); cocoons of *A. leucopoda* attached to the lower surface of an elm leaf (d). (In colour at [www.bulletinofinsectology.org](http://www.bulletinofinsectology.org))

monitoring activities were carried out from April to November. A single site, already infested by *A. leucopoda* in 2009 (the parking area of Alpe-Adria A23 motorway called “Cormor Est”, Treppo Grande UD, at the north of Udine), was monitored every two weeks (April to September), all the others were visited once. The observations were carried out along roadsides, at the margins of groves and in urban areas. The elms were growing alone or in mixed arboreal vegetation.

Geographical coordinates and the altitude above sea level were recorded for each surveyed site.

A site was considered infested when the presence of the sawfly (e.g. larvae, cocoons and adults) or its damage (e.g. zigzag patterns on leaves) on the attacked plants were observed.

#### Species bionomics

During the field monitoring, the presence of different stages of *A. leucopoda* on elms was recorded. Larvae and adults were collected for lab observations. Larvae (L1-L6 instars) were preserved in 70% ethanol, and pupae into cocoons and adults were stored at  $-20^{\circ}\text{C}$ . The rearing of mature larvae (L6 instar) was carried out mainly to obtain adults. Cages (size  $50 \times 50 \times 50$  cm) with several dozen larvae and fresh elm twigs were kept in an environmental chamber at  $23 \pm 1^{\circ}\text{C}$  under a 16L:8D photoperiod and 80% relative humidity. After pupation, elm leaves with cocoons were collected and placed in glass Petri dishes (15 cm diameter) until the emergence of adults.

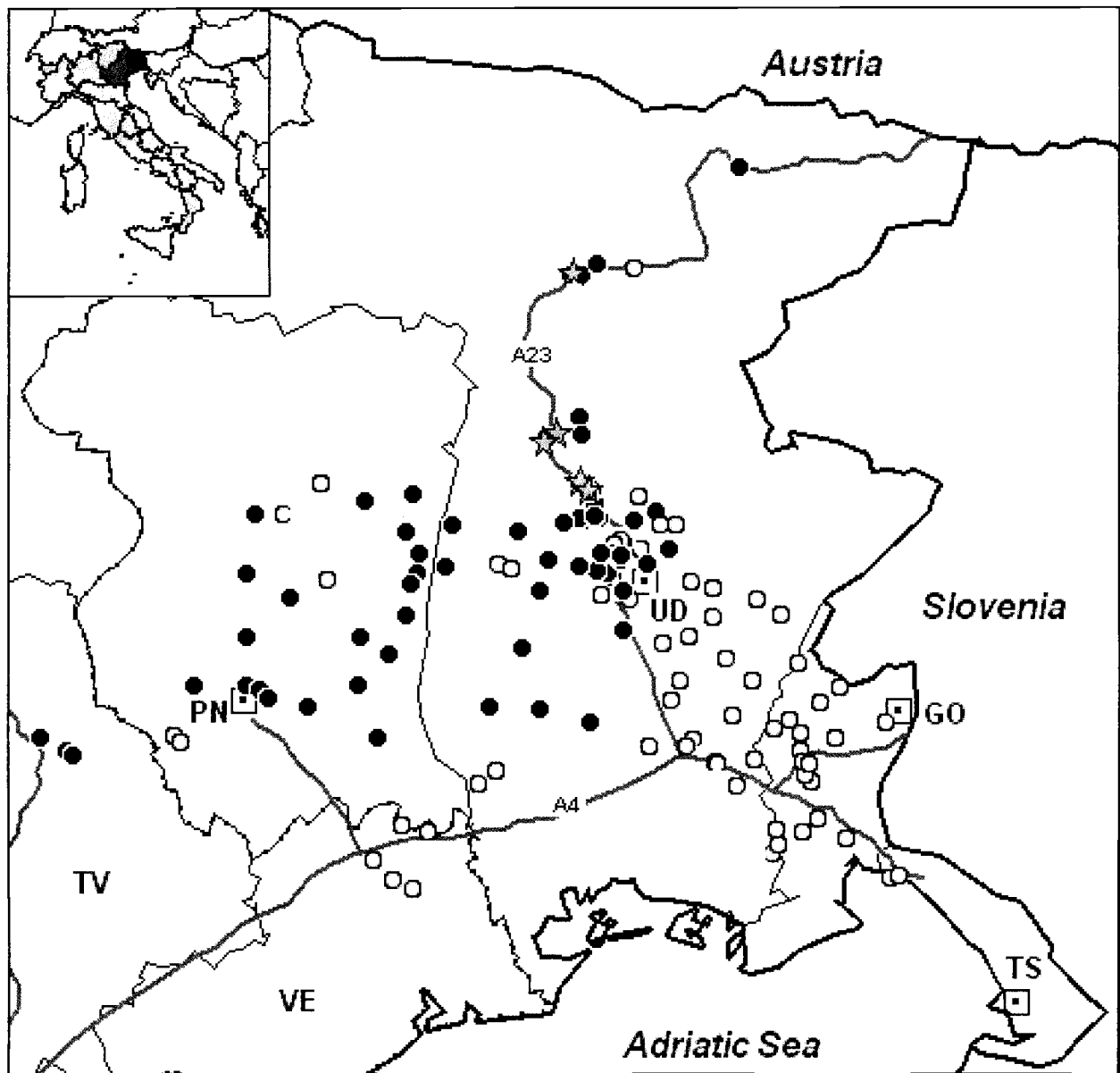
## Results and discussion

### Distribution

In 2009, a mass occurrence of *A. leucopoda* larvae was detected in five parking areas along the motorway between Udine (parking area “Cormor Est”, Treppo Grande UD, 174 m a.s.l.) and Amaro UD in the Canal del Ferro valley (parking area “Carnia Ovest”, Amaro UD, 276 m a.s.l.) (figure 2). The elms in these sites were visited in July-August at which time they appeared severely damaged or completely defoliated. In the following year the same elm trees were heavily defoliated once again.

At the end of the survey in 2010, the pest was observed in 68 of the 132 investigated sites in the Friuli Venezia Giulia and Veneto regions (figure 2).

In Friuli Venezia Giulia, the species occurred in the districts of Udine (45 infested sites out of 80 inspected) and Pordenone (20 infested sites out of 26 inspected) and it was absent from the districts of Gorizia (17 uninfested sites out of 17 inspected) and Trieste (2 uninfested sites out of 2 inspected). It appeared to be widespread, especially on the high plains of the Udine and Pordenone districts. In the mountain areas, e.g. Canal del Ferro and Valcanale, of the Udine district, four sites of infestation were observed (out of 5 inspected) near the border with Austria (Carinthia). However, the species was not detected on elms growing on the southeastern plain of the Udine district (20 uninfested sites out of 20 inspected).



**Figure 2.** Distribution of *A. leucopoda* detected in 2009 and 2010 in north-eastern Italy (Friuli Venezia Giulia and Veneto regions). Grey stars indicate the infested sites observed along the A23 motorway in 2009 and 2010; black circles indicate the other infested sites recorded in 2010; white circles indicate the sites where the species was absent in 2010.

In Veneto, samplings conducted in the eastern part of the Treviso district from sites with elms have shown the occurrence of the pest (3 infested sites out of 3 inspected), while those undertaken so far in the eastern part of the Venice district have not revealed the presence of the sawfly (4 uninfested sites out of 4 inspected).

The species was found on sites with an altitude ranging from 21 m a.s.l. (Zoppola PN) to 678 m a.s.l. (Val Canale, Malborghetto Valbruna UD).

Overall, at the end of 2010 in north-eastern Italy the species had spread across an area of more than 1,200 km<sup>2</sup>. However, some areas are not yet entirely invaded by the sawfly, as is the case in the environs of Udine, where the presence of several uninfested sites not too distant from infested areas has been observed. In the majority of infested sites, the population density of the

sawfly was very low, indicating a recent colonization, in particular in the western part of the studied area (Pordenone and Treviso districts).

The most severely infested sites, which were found along the A23 motorway, were possibly colonized first. Therefore, as the sawfly has been detected in Europe since 2003, first in Poland and Hungary (Blank *et al.*, 2010), its arrival in Italy appears to be associated with its spread by road traffic. In fact, completely defoliated elms were observed in motorway parking areas where vehicles (cars and trucks) often stop in transit from central Europe to Italy. Similarly, long-distance dispersal of the horse chestnut leafminer *Cameraria ohridella* Deschka et Dimic by vehicle transport (Heitland and Metzger, 1997; Pavan and Zandigiacomo, 1998; Skuhravy, 1999) has been proposed.

**Table 1.** Main climatic parameters reported for the capital cities of the six monitored districts in north-eastern Italy, A-Udine, B-Pordenone, C-Gorizia, D-Trieste, E-Treviso, F-Venezia, and those of other two localities, G-Budapest (Hungary) and H-Sapporo (Hokkaido Island, Japan), where *A. leucopoda* was studied by Blank *et al.* (2010). References: \*ARPA FVG-OSMER, 2010; \*\*Aeronautica Militare Italiana, 2008; \*\*\*World Climate Home, 2010.

locality	latitude	longitude	altitude m a.s.l.	Temperature mean value °C			precipitation mean annual value mm
	N	E		annual	January	July	
A*	46°04'	13°14'	91	13.3	3.7	22.9	1451
B*	45°57'	12°39'	23	13.1	3.0	23.3	1417
C*	45°56'	13°37'	85	13.4	4.1	23.3	1481
D*	45°39'	13°46'	1	15.7	6.8	25.0	859
E**	45°39'	12°11'	23	13.0	3.2	23.3	928
F**	45°26'	12°20'	2	13.0	3.3	23.0	748
G***	47°31'	19°02'	120	11.17	-0.5	21.5	563
H***	43°03'	141°20'	17	8.22	-4.6	20.2	1130

### Biological notes

In 2010, in the site that was frequently visited (parking area “Cormor Est”), the first females appeared in the second half of April (from 22 April) and the late instar larvae (L6) and cocoons were found at the beginning of May (from 6 May). In this site, larvae and adults were repeatedly observed up to August, when completely defoliation of elms was occurred. Besides, throughout April-August adults and larvae were found across several other surveyed sites too. A total of about 150 adults were collected in the most infested sites of the Udine district. All specimens were females.

In the larval rearing cages, on fresh Siberian elm leaves, the mature larvae (L6 instar) collected on early May (6 May) began pupation two days later (on 8 May). The obtained cocoons were of a loosely spun form with a net-like structure, attached to the lower surface of elm leaves. The first females emerged ten days later (on 17 May). No males were obtained. Two days after the emergence, without prior mating, females laid eggs singly in consecutive teeth at the edge of elm leaves, suggesting parthenogenetic reproduction as observed in other European countries and Japan (Blank *et al.*, 2010). The females died after laying eggs and no natural enemies were found in the rearing cages.

The preliminary phenological data show that the Italian *A. leucopoda* completes the first generation in mid May, in about 28 days, and that the species is multivoltine. Considering the climatic parameters of some localities representative of the surveyed sites of north-eastern Italy lowlands and those of the two studied sites in Hungary and Japan (Blank *et al.*, 2010) (table 1), the same period of first emergence of the females relative to the investigated sites in Italy and Hungary agree with similar temperature value between the two geographical areas. Besides, a month earlier emergence of the females in north-eastern Italy than in northern Japan, agree with the different temperature value between these areas (in particular warmer winters and summers in the former area). For the same reason, it could be assumed that in northern Italy the species develops four generations per year as in northern Japan (Blank *et al.*, 2010), or more.

The defoliation by *A. leucopoda* was detected on wild

elms found in hedgerows and woods, and on ornamental elms in urban areas. On the plains, field elm (*Ulmus minor* Mill.) and Siberian elm (*Ulmus pumila* L.), and their possible hybrids were damaged. Also wych elm (*Ulmus glabra* Huds.) detected at a mountain site in Valcanale was attacked by the sawfly. In this survey, Siberian elm was found to be more sensitive to the pest than field elm.

The elms defoliated during spring and summer produced new leaves later in the same year. Elm trees completely defoliated in 2009 produced leaves in 2010, however, some dying branches were observed. Until now, no elms attacked by *A. leucopoda* have been found dead in north-eastern Italy.

Damage caused by larvae and adults of the elm leaf beetle (*Xanthogaleruca luteola* Muller) was also often observed on elm leaves.

### Concluding remarks

Considering the widespread presence of elms, the rapid reproduction enhanced by parthenogenesis and the absence of efficient natural enemies in Europe (Blank *et al.*, 2010), it is possible that *A. leucopoda* could quickly increase its abundance and distribution in Italy and other European countries. The foliar damage caused by this invader is detrimental to the aesthetic value of elm trees. Moreover, sawfly attacks could dramatically increase the decline of elms already suffering from Dutch elm disease transmitted by bark beetles (*Scolytus* spp.) (Webber, 1990; Faccoli, 2000) and elm yellows transmitted by leafhoppers (Pavan, 2000; Carraro *et al.*, 2004). Further investigations are required to define the distribution, life history and behaviour of *A. leucopoda*, and to detect suitable natural enemies for biocontrol of the pest.

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