

## First record in Belgium of the invasive sawfly *Aproceros leucopoda* (Hymenoptera: Argidae) and some related ecological data

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### Abstract

*Aproceros leucopoda* Takeuchi, 1939 is an argid sawfly that originated in East Asia and it has been mentioned during the last ten years from several European countries, often as a pest. The larvae of this species feed on elm (*Ulmus* spp.). The characteristic feeding pattern on leaves was first discovered in Brussels (Belgium) during July 2013, and a larva was discovered near this city during August 2013. Some ecological information and chemo-ecological data are presented and discussed, including the following points: under laboratory conditions, *A. leucopoda* can feed on plants other than *Ulmus*; both larval and prepupal stages emit a lemon-smelling volatile secretion that may have some defensive function against invertebrate predators; the use of pesticides against the sawfly is rather irrelevant.

**Keywords:** *Aproceros leucopoda*, Argidae, Belgium, first record, larva, chemical ecology

### Résumé

*Aproceros leucopoda* Takeuchi, 1939 est un symphyte Argidae originaire de l'Asie de l'Est et qui a été mentionné durant les dix dernières années dans différents pays Européens, souvent comme un ravageur. Les larves de cette espèce se nourrissent d'orme (*Ulmus* spp.). Le dégât caractéristique occasionné sur les feuilles a d'abord été découvert à Bruxelles (Belgique) en juillet 2013, et une larve a été découverte aux abords de cette ville en août 2013. Quelques informations écologiques et données chimio-écologiques sont présentées et discutées, en ce y compris les points suivants : en laboratoire, *A. leucopoda* peut se nourrir d'autres plantes que l'orme ; les stades larvaires et prépupal émettent une sécrétion volatile à odeur de citron et qui semble avoir une certaine fonction défensive vis-à-vis de prédateurs invertébrés ; l'utilisation de pesticides contre ce symphyte est plutôt non pertinente.

### Samenvatting

De Argide bladwesp *Aproceros leucopoda* Takeuchi, 1939 is afkomstig van Oost Azië en werd in de laatste tien jaren in verschillende Europese landen vermeld, vaak als een plaag. De larven van deze soort voeden zich met iep (*Ulmus* spp.). De karakteristieke schade aan de bladeren werd in juli 2013 in Brussel (België) ontdekt, en een larve werd augustus 2013 aan de rand van deze stad gevonden. Sommige ecologische en chemo-ecologische gegevens worden gepresenteerd en besproken, inclusief volgende vaststellingen: in het laboratorium kan *A. leucopoda* zich met andere planten dan iep voeden, larven en eonimfen stoten een vluchtige citroengeurige secretie af die een defensieve functie ten opzichte van ongewervelde roofdieren schijnt te hebben, het gebruik van bestrijdingsmiddelen tegen deze bladwesp is eerder irrelevant.

## Introduction

The sawfly *Aproceros leucopoda* Takeuchi, 1939 (Hymenoptera, Argidae) is invasive in Europe since a few years as reviewed by BLANK *et al.* (2010). Originating from East Asia, it reached European countries with first records for Hungary and Poland in 2003, Romania in 2005, Ukraine in 2006, Slovakia in 2007, Moldavia in 2008, Austria and Italy in 2009 (BLANK *et al.*, 2010; ZANDIGIACOMO *et al.*, 2011, and literature therein), Germany and Slovenia in 2011 (KRAUS *et al.*, 2011; DE GROOT *et al.*, 2012). The larva of *A. leucopoda* is phytophagous, as for nearly all sawflies, and it is oligophagous on elm, *Ulmus* spp. (Ulmaceae). Its vernacular name, the zigzag elm sawfly, comes from the typical zigzag pattern eaten by the first larval instars from the leaf-edge towards its centre, usually between two secondary leaf veins. The prepupal stage spins a cocoon, often attached to the underside of a leaf or a twig.

The European and Mediterranean Plant Protection Organization (EPPO) mentions *A. leucopoda* as a pest (with entry code 'EPPO RS 2011/198') since September 2011. Several biological traits of this sawfly can explain its status as a pest (BLANK *et al.*, 2010). First, it reproduces by parthenogenesis, so that females lay viable eggs without copulating, and males are unknown. Second, it is multivoltine with 4–5 generations per year occurring from May to September, with each generation developing within about only one month. Third, it is restricted to one plant genus, but not on a given species within this genus, which means that naturally occurring elms as well as their cultivars can be attacked. Elms are often planted in parks, and along roads and railways, etc. This all contributed to its invasion throughout most European countries. It is unknown, however, why the invasion did not occur earlier, or whether natural enemies already control its population dynamics to some extent.

Here, the occurrence of *A. leucopoda* in Belgium is documented and some preliminary information about the chemical ecology of the species given. These data are also discussed in relationship to its status as a pest.

## Material and methods

Field observations were recorded, among others, by taking pictures with the cameras Nikon Coolpix P300 and Pentax Optio W10 (and the pictures are copyrighted by the author). A few qualitative observations were also performed in the laboratory. Vouchers of leaves and larvae are kept at the Royal Belgian Institute of Natural Sciences (RBINS).

## Results and discussion

By a fortuitous checking of plant leaves, the typical feeding pattern of *A. leucopoda* was first observed at the railroad station Saint-Job (Uccle, *i.e.* a township belonging to Brussels, Belgium; N50°47'39" E004°21'43", altitude 80 m) on 25.VII.2013. Several leaves, most of them from shoots of the same *Ulmus* sp. shrub/tree, were obviously attacked by larvae (Figs 1-3), but neither the larvae themselves nor cocoons were found. Similar observations of leaves attacked but without occurrence of larvae or cocoons were made at the railroad station Boondael (Ixelles, Brussels; N50°48'06" E004°23'37", altitude 80 m) on 12.VIII.2013.

Along the two following highways, elm trees or shrubs occurred at parking places and they were checked for the presence of (feeding patterns of) *A. leucopoda*, but without success: highway E411 (17.VIII.2013), direction Brussels to Namur, parking 'Nil-Saint-Martin' (near Corroy-le-Grand) and parking 'Aische-en-Refail' (between Grand-Leez and Perwez); highway E40 (22.VIII.2013), direction Brussels to Liège, parking 'Louhin' (between Waremme and Hognoul). Elm trees and shrubs were also checked, again without success, in the close vicinity of the RBINS that is inside the urban area of Brussels.

The occurrence of *A. leucopoda* in Belgium was definitively confirmed by the finding of one old larval instar on a shrub (composed of shoots) of *Ulmus campestris* (height: 1.5 m) that was growing along a pond ('ganzepootwijver', Hoeilaart; N50°45'50", E004°25'35", altitude 55 m; 22.VIII.2013; sawfly collection code P3793; Figs 4-5). One leaf on another branch and at another part of the same shrub was also attacked, but no larva was present there. A few other elm trees or shrubs occurred in the vicinity, but without feeding patterns, and no other elms were found in a wider vicinity (<100 m).



Fig. 1. Feeding damage by *A. leucopoda* on elm. Uccle, 25.VII.2013.



Fig. 2. Feeding damage by *A. leucopoda* on elm. Uccle, 25.VII.2013.



Fig. 3. Feeding damage by *A. leucopoda* on elm. Uccle, 21.VIII.2013.



Fig. 4. Elm shrub beside a pond and on which was found the larva of *A. leucopoda* shown in Figure 5. Hoeilaart, 22.VIII.2013.



Fig. 5. The larva of *A. leucopoda* that constitutes the first record of this species in Belgium. Hoeilaart, 22.VIII.2013.



Fig. 6. One of the hop leaves on which was experimentally-placed a larva of *A. leucopoda* (i.e., the one shown in Figure 5). The larva only received a few hop leaves during 24 hours, from 23 to 24.VIII.2013, after which the picture was taken from the one leaf that had been fed upon.

The collected individual started to spin a cocoon (that was loosely spun) in the evening of 25.VIII.2013.

The specific zigzag feeding pattern of *A. leucopoda*, as first detected in Uccle, was already an explicit proof of its occurrence in Belgium. Indeed, elms support a distinctive entomofauna (e.g. HOFFMANN, 1942; MARTINEAU, 1984), and the feeding pattern of a phytophagous insect (HEINRICH, 1979) often constitutes a 'behavioural signature' of the species. Moreover, the occurrence of

*A. leucopoda* in Belgium is not surprising in that its West Palearctic geographic distribution already extended westward to Southeastern Germany (KRAUS *et al.*, 2011).

The host specificity of *A. leucopoda* is low within the genus *Ulmus* (BLANK *et al.* 2010), but, as far as known, no other plant genera have been used in feeding tests. It is therefore not excluded that *A. leucopoda* may attack other plant genera than *Ulmus*. In this context, a couple of full-grown larvae were provided with intact and young leaves of hop (*Humulus lupulus* L.) in no-choice laboratory conditions. They accepted this plant, more than by just nibbling the leaf (*e.g.*, Fig. 6), although they were prompter to feed on elm leaves after this testing. Hop was tested because it belongs to the family Cannabaceae that is close to the Ulmaceae (SYTSMA *et al.* 2002), and this may explain its relative acceptance by the sawfly, secondary plant metabolites being probably similar between the two groups of plants. The screening of the diet breadth in *A. leucopoda* requires further attention.

As described above, only a few cases of elm leaves attacked by *A. leucopoda* have been recorded in Belgium so far, meaning that pest status still has not been reached. But the species has caused serious damage to elms in other European countries. For instance, in 14 Romanian forest plots the average defoliation was between 74 and 98% for 12 to 60 year-old trees of *Ulmus glabra* Huds. (BLANK *et al.*, 2010). The question arises as to whether natural enemies may control its population dynamics to some extent. When a species becomes invasive following its accidental introduction in a new area far away from its native geographic distribution, then specialized predators and parasitoids are often lacking in this new area. In the case of *A. leucopoda*, the only natural enemy known at all is a tachinid parasitoid, *Blondelia nigripes* (Fallén, 1810), that is recorded from Japan and Europe, and that is known to attack larvae of several sawfly and numerous Lepidoptera species (HERTING, 1960; SHIMA, 1984). Thus, no specialized natural enemies of *A. leucopoda* are known. In contrast, while searching for the possible presence of *A. leucopoda* in the frame of the present study (in Uccle and Hoeilaart; see above), it was repeatedly observed that wasps (*Vespula*) were flying and foraging among the foliage of elms. These generalist predators may potentially encounter and eventually prey upon sawfly larvae (MÜLLER & BRAKEFIELD, 2003). Similarly, workers of the ants *Lasius brunneus* (Latreille, 1798) and *Myrmica rubra* (Linné, 1758) were foraging on elm leaves (Ixelles; see above), and such polyphagous ants are known as important predators of sawfly larvae (BOEVÉ *et al.*, 2013). Besides entomophagous insects, birds may also impose a predation risk on *A. leucopoda*. However, the larvae are small-sized and cryptic so that birds may have difficulty in detecting them visually.

Anti-predator defensive strategies of sawfly larvae often rely on chemicals (BOEVÉ *et al.*, 2013). Among the Argidae, *Arge* larvae possess non-reversible ventral glands and *Arge pullata* (Zaddach, 1859) emits volatiles such as aromatic compounds (PETRE *et al.*, 2007). In the case of *A. leucopoda*, it is possible to perceive a lemon-like odour, by disturbing a larva (Ewald Altenhofer, personal communication, 2009) but also by dislodging a prepupa (*i.e.* eonymph) from its cocoon and then by disturbing it. Chemical analyses of total extracts of individuals revealed the presence at larval and prepupal stages of nerol as a major compound (JLB and Stefan Schulz, unpublished results). This monoterpene is one of the two isomers of 3,7-dimethyl-2,6-octadienal (*i.e.* citral) that is active as a repellent against ants (BOEVÉ *et al.*, 2009) and wasps (ZHANG *et al.*, 2012). Own observations in the laboratory confirm this bioactivity against *Vespula* spp. Four prepupae were taken out of their cocoons: two were then gently rolled in soft paper, to remove their secretion, whereas the two others were not treated. All four specimens were then offered concurrently to a group of 40 wasps in a glass container (60 x 40 x 40 cm<sup>3</sup>), and their status checked after 16 hours: the treated prepupae were killed, whereas the untreated ones were still alive and intact. However, it is unknown whether the absolute quantities emitted by the sawfly, especially by the first larval instars, are sufficient for effectively protecting them against such invertebrate predators.

To control *A. leucopoda*, pesticides have been sprayed in Hungary and Japan, but it can be expected that: “in view of the wide distribution of this species in Europe and the ability of its imagines to quickly re-invade a treated area, the local application of insecticides is unlikely to prove an effective way of controlling this pest” (BLANK *et al.*, 2010). Elms often show a patchy distribution and grow in mixed forests, which decrease even more the possible effectiveness of such applications. Moreover, applications may be also irrelevant considering the following observations on (unmanaged) population dynamics. It has been remarked at the location Traismauer (Austria) that the population of *A. leucopoda* is obviously declining: it was a pest especially in 2009–2010, becoming less abundant afterwards, up to being rare in 2013 (E. Altenhofer, personal communication). The reason for this

decline remains unknown. A particular climatic condition such as the hot summer 2013 does not seem to provide an explanation since the decline started earlier. An induced host-plant defence in response to successive and severe damage may be a hypothesis worthy of future testing.

### Conclusions

After the first record of *A. leucopoda* from Belgium, as described here, this invasive sawfly species will probably become a pest on elms in this country during the next years, just as it is already in other European countries. Among natural enemies, some generalist entomophagous insects may play a certain role in preying upon the sawfly larvae although these are chemically defended, by emitting volatiles. Finally, it is likely that this sawfly population will decline after several years, even in the absence of (artificial) controlling measures.

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