

# On foreign land: the conquest of Europe by *Cinara curvipes* (Patch, 1912)

Roman Hałaj<sup>1</sup>, Barbara Osiadacz<sup>2</sup>

<sup>1</sup> The Upper Silesian Nature Society, Huberta St. 35, PL 40-543 Katowice, Poland

<sup>2</sup> Department of Entomology and Environmental Protection, Poznań University of Life Sciences, Dąbrowskiego St. 159, PL 60-594 Poznań, Poland

<http://zoobank.org/042F2C13-2C7E-433C-BE06-BA26D5DCDCC3>

Corresponding author: Barbara Osiadacz (osiadacz@up.poznan.pl)

## Abstract

Received 26 September 2015

Accepted 30 October 2015

Published 2 December 2015

Academic editor:

Roger Blackman

*Cinara curvipes* (Patch, 1912), a Nearctic aphid species first recorded in Europe at the turn of the millenium, has invaded almost one quarter of the continent during the past 15 years. This communication gives information about the first reports from Poland, summarises the species' conquest of Europe and gives forecasts and possible explanations for such a rapid expansion. An identification key to aphid species on *Abies* is provided to help monitor its further expansion, as well as for the benefit of forestry and phytosanitary services.

## Key Words

biocapacity  
climatic changes  
Aphidoidea  
invasiveness forecast  
species acclimatization  
zoogeography

## Introduction

About 200 aphid species of the genus *Cinara* (Lachnidae) are known worldwide: 21 of them infest *Abies* spp. (Blackman and Eastop 2015), but only three species have so far been reported from Europe (Holman 2009).

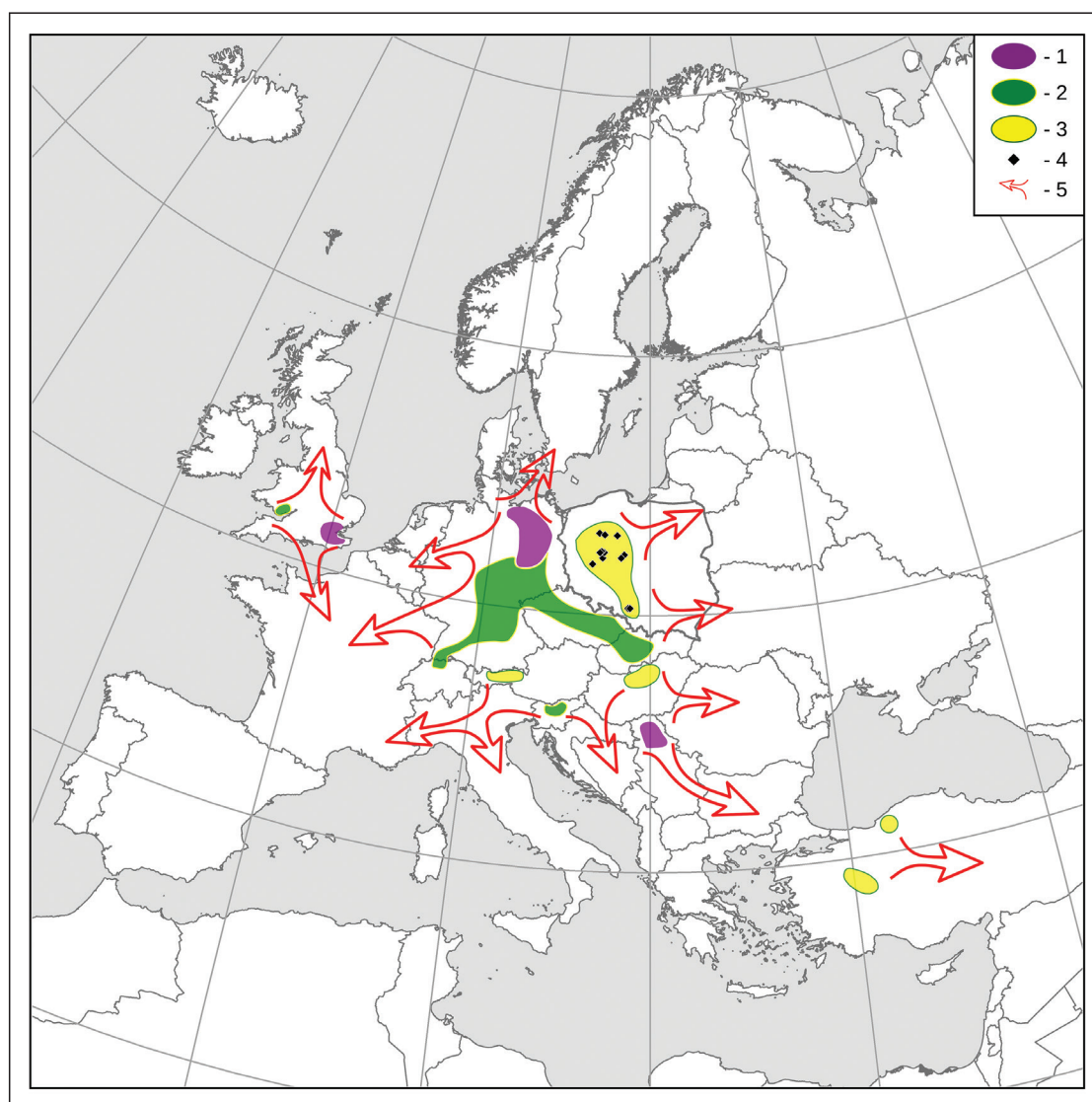
Numerous reports have been recently published on harmful aphid species – both native (e.g. Hałaj and Osiadacz 2015, Martin 2010, Osiadacz and Hałaj 2014, Vučetić et al. 2014) and alien (e.g. Cœur d'acier et al. 2010, Hałaj et al. 2011, Pérez Hidalgo and Mier Durante 2012, Rakauskas et al. 2015) – expanding their distribution ranges in Europe. *Cinara curvipes* (Patch) – the bow-legged fir aphid – is one such alien species, originally from North America, where it is widespread (Maw et al. 2000; Voegtlin and Bridges 1988). The first reports of *C. curvipes* in Europe date back to the late 1990s, and interestingly, relate almost simultaneously to three disjunct

regions of the continent: the United Kingdom (Martin 2000), Germany (Gottschalk 2001, Scheurer 2001) and Serbia (Poljaković-Pajnik and Petrović-Obradović 2002). Further reports, after a period without any, come from 2007–2009, when *C. curvipes* was still expanding its distribution in the United Kingdom (Baker 2009) and Germany (Scheurer 2009), but in the meantime it was found in Switzerland (Angst et al. 2007), the Czech Republic (Olbrechtová 2007), Slovakia (Nakládal et al. 2007) and Slovenia (Jurc et al. 2009). There were no further reports of a significant expansion of its range until 2013–2014, when it was found in Hungary (Bodor 2013) and Austria (Perny 2014), and there is a recent report from Turkey (Görür et al. 2015). In 2014 it was found in Poland for the first time (Gliwice, 11.04.2014; Zabrze, 26.04.2014). The following year, as well as in further localities in Upper Silesia (Bytom, 16.05.2015; Ruda Śląska, 24.05.2015), it was found in the Wielkopolska-Kujawy Lowland (Białe

Blota near Bydgoszcz, 03.05.2014; Konin, 01.06.2015; Bukówiec Górny near Leszno, 09.05.2015; Poznań, 21.05.2015) (Fig. 1). Aphid samples (wingless and winged morphs) were collected from colonies of several hundred individuals that were feeding on the lower trunk parts or older branches of *Abies concolor* (Fig. 2) and *A. alba* (Upper Silesia: Ruda Śląska, 24.05.2015).

The information on the sightings of this species, although not 'hard evidence', may suggest an explanation for this aphid expansion, namely, that it is happening by natural dispersal rather than by trade in infested plants (although this possibility cannot be ruled out). Winged females (migrants) disperse not only through active flight; above all, given the significant distances between sightings, they appear to move passively with the aerial plankton. It is reasonable to assume that this could be the way in which the species has invaded Europe. It must be pointed that large scale dispersion happens occasionally. Irruptions sometimes occur, especially when warmer winters are favourable to the species' development.

This aphid can undergo not only a complete life cycle with sexual morphs and overwintering eggs (holocyclic development), but also permanent parthenogenesis (anholocyclic development) with overwintering wingless adults and larvae. During mild winters the survival rate of these morphs increases significantly and in early spring very large colonies appear, in which the proportion of winged morphs can reach 30%, and later as much as 90% (Scheurer and Binazzi 2004). The potential to infest new host plants in new areas is therefore very considerable. One can therefore speculate that local and global climate changes leading to warming (Spencer et al. 2015), and boosting the activity of sucking insects (Rouault et al. 2006), constitute one of the factors governing the expansion of the bow-legged fir aphid. Moreover, only a few predators that naturally control its abundance have been found (Olbrechtová 2007, Scheurer and Binazzi 2004), and no parasitoids have been reported (Starý and Havelka 2008). During this study larvae of *Harmonia axyridis* (Pallas) (a ladybird, also invasive) were for the first time



**Figure 1.** Distribution of *Cinara curvipes* in Europe – records in particular periods and predicted expansion. **1.** recorded in 1999–2001; **2.** recorded in 2007–2009; **3.** recorded in 2013–2015; **4.** 1<sup>st</sup> records in Poland; **5.** probable expansion routes.





**Figure 2.** *Cinara curvipes* on the trunk of *Abies concolor* (29 May 2015) [photo by M. Kręciała].

found in these aphid colonies, but only at two sites, in small numbers, and not during the peak abundance of the aphid population ( $\pm 3$  larvae / 200 aphids). As observed by others (Jurc et al. 2009, Scheurer 2009, Scheurer and Binazzi 2004) ants (*Lasius niger* L., *Myrmica rubra* L.) were present in some aphid colonies, but only at one quarter of the sites examined by us.

*C. curvipes* is an oligophagous species which in its original area infests many coniferous trees (*Abies balsamea*, *A. concolor*, *A. grandis*, *A. lasiocarpa*, *A. magnifica*, *A. religiosa*, *Picea engelmannii*, *P. glauca*, *Pinus contorta*). Most of these plants are grown in Europe as decorative trees and here, too, they were found to have been attacked by the bow-legged fir aphid. However, its first sighting was on the Mediterranean *Cedrus atlantica* (Martin 2000), and later ones were on coniferous trees from Asia (*Abies koreana*, *A. nordmanniana*, *A. veitchii*, *Cedrus deodara*, *C. libani*) (Bodor 2013, Gottschalk 2001, Scheurer 2009). Interestingly, in Europe bow-legged fir aphids were found to be infesting American conifer species (*Abies procera*, *Picea pungens*, *Pseudotsuga menziesii*, *Tsuga canadensis*) that they have not been recorded from in North America. However, it should be noted that there are no European records from *Pinus*, and only one record of it occurring on North American *Pinus* (Voegtlin 1976, cited in Blackman and Eastop 2015).

This constant increase in the number of host species confirms the expansive nature of this species. In addition, being an acclimatised alien species, it can pose

a significant threat to native plants (Hałaj et al. 2011). Earlier reports (Jurc et al. 2009, Scheurer 2009) and our current observations confirm that native European coniferous trees (*Abies alba* and *Picea omorika*) are being attacked. Although at present the threat posed by this pestiferous aphid is deemed low (EPPO 2015), it did lead to the death of the *A. concolor* trees it invaded in Serbia (Poljaković-Pajnik and Petrović-Obradović 2002). Our observations from this year (2015) suggest that the infestation by *C. curvipes* of one of the two *A. alba* that it colonised (about 15-year-old, 3.5 m tall trees, in a private garden in Ruda Śląska) caused its condition to deteriorate (signs of drying out). In addition, the enormous quantities of honeydew produced by the vast colonies of these aphids decrease the aesthetic value of the attacked plants (also because they then attract large numbers of wasps and ants), and the possible growth of mould can lead to economic losses (Furniss and Carolin 1978), which is of importance to growers of ornamental conifers (Bodor 2013, Perny 2014). During its peak production time (in late summer and autumn), honeydew was collected by bees. This was not a frequent or widespread phenomenon in Poland, although it has been observed by other workers (Scheurer and Binazzi 2004). For an unexplained reason (possibly related to chemical composition?), bees seem to prefer the honeydew of indigenous Lachnidae species.

*C. curvipes* has a high biological potential: holo- and anholocyclic development, oligophagism leading to

polyphagism, vast colonies with a large proportion of winged morphs and their dispersal with the aerial plankton, and a small number of natural enemies. Consequently, we expect the species' range to expand further and the number of host plant species to increase. Since this aphid species has been reported from European coniferous trees, natural fir forests need to be monitored for the presence of *C. curvipes*,

especially in montane and submontane areas, which are especially vulnerable to change.

Fir trees, both native and introduced, are infested by several other aphid species besides *Cinara* spp. (Aphidoidea). A key is appended to facilitate their identification by entomologists and other interested parties (e.g. forest and phytosanitary services).

## Key to aphids (Aphidoidea) feeding on *Abies* in Europe

- 1 Aphids feed on underground parts of firs ..... 2
- Aphids feed on ground parts of firs ..... 3
- 2 Siphunculi absent, aphids live in colonies densely covered with wax ..... *Prociphilus* spp.  
[Two species whose wingless generation morphs on the fir roots are nearly indistinguishable. In *P. bumeliae* (Schrank, 1801) the posterior pair of wax gland plates on head is better developed than the anterior pair, while in *P. fraxini* (Fabricius, 1777) the posterior pair of these plates is not better developed or is absent].
- Siphunculi present, aphids live in colonies not covered with a dense wax..... *Cinara confinis* (Koch) (see below)
- 3 Siphunculi very long, many times longer than the diameter of their base (up to about a quarter of the length of the body) ..... 4
- Siphunculi as broad hairy cones, not longer than their diameter at the base, or absent ..... 5
- 4 Processus terminalis of last antennal segment at most 1.6 times as long as the base of this segment (from 1.1 to 1.6). Life wingless pale green, with two darker green longitudinal stripes: green spruce aphid ..... *Elatobium abietinum* (Walker, 1849)
- Processus terminalis of last antennal segment at least 1.7 times as long as the base of this segment (from 1.7 to 2.5). Life wingless greenish, similar in colour to their host's needles ..... *Elatobium blackmani* Binazzi & Barbagallo, 1997
- 5 Head of wingless adults fused to pronotum. On dorsum of abdomen there are well developed glandular plates and therefore the living aphids are densely covered with wax wool. Winged morphs with the characteristic long (extending to the tip of the wing), narrow and pointed (sickle-shaped) pterostigma: balsam twig aphid ..... *Mindarus abietinus* Koch, 1857
- Head of wingless adults not fused to pronotum. Dorsum of abdomen devoid of glandular plates and therefore the living aphids are not densely covered with wax wool. Winged morphs with a pterostigma of another shape ..... 6
- 6 Live wingless aphids green (very rarely pale brown), and feeding solely on young shoots and small branches, where they stay on the needles. Eyes are very clear and red. Siphuncular cones pale. Maximum diameter of the base of the siphuncular cone less than 3 times the diameter of the siphuncular aperture (less than 0.3 mm): green-striped fir aphid.....  
..... *Cinara pectinatae* (Nördlinger, 1880)
- Live wingless aphids dark (brown or greenish-black to black), feeding in colonies on the trunk or branches. Eyes are not very clear, darkish. Siphuncular cones dark. Maximum diameter of the base of the siphuncular cone more than 3 times the diameter of the siphuncular aperture (more than 0.3 mm) ..... 7
- 7 Siphuncular cones with hairs of two types: thicker and long – about 1.5-2 times as long as the diameter of the siphuncular aperture; thin and short – about as long as the diameter of the siphuncular aperture, usually shorter. Live wingless aphids dark brown or greenish-black, with a double row of blackish, slightly shining speckles and small flecks of fine wax in transverse rows. Hind tibiae are straight. Aphids feed on ground plant parts, but during the summer they have also been found on the roots: black-stem aphid ..... *Cinara confinis* (Koch, 1856)
- Siphuncular cones only with long hairs, usually about 1.5 times as long as the diameter of the siphuncular aperture, sometimes longer. Live wingless aphids shiny or dull grey-black, sometimes developing a covering of pale grey wax, especially on the thorax and along each side of the dorsum. Hind tibiae are distinctly curved: bow-legged fir aphid.....  
..... *Cinara curvipes* (Patch, 1912)

## Acknowledgments

We are very grateful to Roger Blackman (Natural History Museum, London, UK) for all comments and linguistic improvement of the manuscript. We would also like to thank Reviewers for all valuable suggestions.

## References

- Angst A, Scheurer S, Forster B (2007) First record of *Cinara curvipes* (Patch) (Homoptera, Aphidina, Lachnidae) on *Abies concolor* in Switzerland. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 80: 247–252.
- Baker EA (2009) Observations of aphids (Aphidoidea) new to Wales. British Journal of Entomology and Natural History 22(4): 235–246.



- Blackman RL, Eastop VF (2015) Aphids on the world's plants. An online identification and information guide. <http://www.aphidson-worldsplants.info> [accessed 07 June 2015]
- Bodor J (2013) Damage of bow-legged fir aphid (*Cinara curvipes* Patch, 1912) in Hungary. *Növényvédelem* 49(6): 273–275.
- Cœur d'acier A, Pérez Hidalgo N, Petrović-Obradović O (2010) Aphids (Hemiptera, Aphididae). Chapter 9.2. In: Roques A et al. (Eds) Alien terrestrial arthropods of Europe. *BioRisk* 4(1): 435–474. doi: 10.3897/biorisk.4.57
- EPPO (2015) EPPO Global Database. <https://gd.eppo.int> [accessed 17 June 2015]
- Gottschalk HJ (2001) *Cinara curvipes* (Patch), Erstfund in Mecklenburg-Vorpommern, ein potentieller Forstschädling. *Mitteilungsblatt des Entomologischen Vereins Mecklenburg* 1: 36.
- Furniss RL, Carolin VM (1978) Western forest insects. Miscellaneous Publications, 1339. U.S. Department of Agriculture, Forest Service, Washington D.C.
- Görür G, Toper Kaygin A, Şenol A, Akyildirim Beğen H (2015) *Cinara curvipes* (Patch, 1912) (Hemiptera; Aphididae) as new aphid species for Turkish aphidofauna. *Artvin Coruh University Journal of Forestry Faculty* 16(41): 37–39.
- Hałaj R, Osiadacz B (2015) Note: *Aphis vitalbae* Ferrari, 1872 (Hemiptera: Aphididae): new finding on ornamental *Clematis* spp. in Poland. *Phytoparasitica* 43(1): 103–106. doi: 10.1007/s12600-014-0417-2
- Hałaj R, Osiadacz B, Klejdysz T, Strażyński P (2011) *Viteus vitifoliae* (Fitch, 1885) a new species of aphid (Hemiptera: Aphidomorpha: Phylloxeridae) in Poland. *Polish Journal of Entomology* 80: 457–464. doi: 10.2478/v10200-011-0033-0
- Holman J (2009) Host plant catalog of aphids. Palearctic Region. Springer, Dordrecht, 1140 pp. doi: 10.1007/978-1-4020-8286-3
- Jurc M, Poljaković-Pajnik L, Jurc D (2009) The first record of *Cinara curvipes* (Patch, 1912) (Homoptera, Aphididae) in Slovenia and its possible economic impact. *Zbornik gozdarstva in lesarstva* 88: 21–29.
- Martin JH (2000) Two new British aphid introductions in 1999, in the context of other additions over the preceding thirty years (Sternorrhyncha: Aphidoidea). *Entomologist's Gazette* 51(2): 97–105.
- Maw HEL, Footitt RG, Hamilton KGA, Scudder GGE (2000) Checklist of the Hemiptera of Canada and Alaska. NRC Research Press, Ottawa.
- Nakládal O, Turčáni M, Šrůtka P (2007) First record of *Cinara curvipes* (Hemiptera: Aphididae) from Slovakia. *Klapalekiana* 43: 201–202.
- Olbrechtová J (2007) First occurrence of *Cinara curvipes* Patch 1912 on white fir (*Abies concolor* (Gordon et Glendinning) Hildebrand 1861) in the Czech Republic. *Aphids and other Hemipterous Insects* 13: 43–49.
- Osiadacz B, Hałaj R (2014) First records of gall-inducing aphid *Pemphigus populi* (Hemiptera: Aphidoidea, Eriosomatidae) in Poland with gall-based key to Central and North European species of the genus. *Entomologica Fennica* 25: 16–26.
- Pérez Hidalgo N, Mier Durante MP (2012) First record of *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley) [Hemiptera: Aphididae] in the Iberian Peninsula. *Bulletin OEPP/EPPO Bulletin* 42(1): 142–145. doi: 10.1111/j.1365-2338.2012.02531.x
- Perny B (2014) Die Coloradotannen-Rindenlaus, *Cinara curvipes* – Ein harmloser Einwanderer aus Nordamerika in Österreichs Christbaumkulturen und Gärten? *Forstschutz Aktuell* 60/61: 28–30.
- Poljaković-Pajnik L, Petrović-Obradović O (2002) Bowlegged fir aphid *Cinara curvipes* (Patch) (Aphididae, Homoptera) new pest of *Abies concolor* in Serbia. *Acta entomologica serbica* 7: 147–150.
- Rakauskas R, Havelka J, Zaremba A (2015) Plum (*Prunus* spp.) aphid guild (Hemiptera: Sternorrhyncha, Aphididae) structure in Lithuania: any impact of an alien aphid species? *Zemdirbyste-Agriculture* 102(1): 81–86. doi: 10.13080/z-a.2015.102.010
- Rouault G, Candau JN, Lieutier F, Nageleisen LM, Martin JC, Warzée N (2006) Effects of drought and heat on forest insect populations in relation to the 2003 drought in Western Europe. *Annals of Forest Science* 63: 613–624. doi: 10.1051/forest:2006044
- Scheurer S (2001) *Cinara curvipes* (Patch) Aktualisierung und Berichtigung unseres bisherigen Wissens über die Rindenlaus. *Ameisenschutz aktuell* 2: 1.
- Scheurer S (2009) „Mattschwarze Tannenrindenläuse“ erobern Wälder, Parks und Gärten. *LWF aktuell* 73: 24–25.
- Scheurer S, Binazzi A (2004) Notes on bio-ecology and ethology of *Cinara curvipes* (Patch), a newly introduced species into Europe (Aphididae Lachninae). *Redia* 87: 61–65.
- Spencer RW, Christy JR, Braswell WD (2015) Version 6.0 of the UAH Temperature Dataset Released: New LT Trend = +0.11 C/decade. <http://www.drroyspencer.com/2015/04/version-6-0-of-the-uah-temperature-dataset-released-new-lt-trend-0-11-cdecade> [accessed 15 June 2015]
- Starý P, Havelka J (2008) Fauna and associations of aphid parasitoids in an up-dated farmland area (Czech Republic). *Bulletin of Insectology* 61(2): 251–276.
- Voegtlin DJ (1976) A biosystematic study of *Cinara* spp. on the conifers of the west-side Sierra forests. PhD thesis, University of California, Berkeley.
- Voegtlin DJ, Bridges CA (1988) Catalogue of the *Cinara* Species of North America (Homoptera: Aphidida). Illinois Natural History Survey, Special Publication 8: 1–55.
- Vučetić A, Jovičić I, Petrović-Obradović O (2014) Several new and one invasive aphid species (Aphididae, Hemiptera) caught by yellow water traps in Serbia. *Phytoparasitica* 42(2): 247–257. doi: 10.1007/s12600-013-0357-2