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THE FIRST RECORD OF *Cinara curvipes* (Patch, 1912) (Homoptera, Aphididae) IN SLOVENIA AND ITS POSSIBLE ECONOMIC IMPACT

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Abstract

The presence of the exotic phytophagous bow-legged fir aphid, *Cinara curvipes*, was detected for the first time in the spring of 2007 on a single silver fir tree (*Abies alba*) in a private garden in Ljubljana, central Slovenia. In the summer and winter of 2007, it was found in two locations on *Abies concolor* trees in parks at Muta, in the north of the country. In Ljubljana, the aphids were eliminated with insecticide spraying in summer 2007, whereas at Muta the colonies did not survive the winter of 2007/2008. The North American species *C. curvipes* has recently been introduced to some European countries (UK, Germany, Serbia, Switzerland, Czech Republic and Slovakia), where it established itself and already causes some damage. The occurrence of *C. curvipes* on *A. alba* confirms the capacity of the aphid for host switching, which could lead to its spreading in silver fir forests. An overview of the relevant literature on the taxonomy, bionomy, and economical importance of *C. curvipes* is provided.

Key words: Aphididae, Lachninae, *Cinara curvipes*, *Abies concolor*, *Abies alba*, forest, Slovenia

PRVA NAJDBA UŠI *Cinara curvipes* (Patch, 1912) (Homoptera, Aphididae) V SLOVENIJI IN NJEN MOREBITNI GOSPODARSKI POMEN

Izveleček

Tujerodna fitofagna dolgonoga jelova uš, *Cinara curvipes*, je bila spomladi leta 2007 prvič ugotovljena na drevesu navadne jelke (*Abies alba*) v zasebnem vrtu v Ljubljani, osrednji del Slovenije. Poleti in pozimi 2007 je bila ponovno najdena na dveh lokacijah v parkih na drevesih dolgoigličaste jelke (*Abies concolor*) v Muti, v severnem delu države. V Ljubljani so uši zatrli s škropljenjem z insekticidom poleti 2007, medtem ko v Muti kolonije uši niso preživele zime 2007/2008. Severnoameriška vrsta *C. curvipes* je bila pred kratkim zanesena v nekatere evropske države (VB, Nemčija, Srbija, Švica, Češka republika, Slovaška), kjer se je ustalila in že povzroča škodo. Pojav vrste *C. curvipes* na navadni jelki potrjuje sposobnost te vrste uši, da zamenja gostitelja, kar lahko omogoči njeno širjenje v jelove gozdove. Podan je literaturni pregled taksonomije, bionomije in ekonomskega pomena uši *C. curvipes*.

Ključne besede: Aphididae, Lachninae, *Cinara curvipes*, *Abies concolor*, *Abies alba*, gozd, Slovenija

INTRODUCTION

UVOD

Harmful organisms are being transported throughout the world in increasing numbers. Many human-assisted immigrants have found suitable conditions for life in new environments and some of them have become serious agricultural or forest pests (SMITH *et al.* 2007).

Over the last 500 years, nearly 2,000 insects and 2,000 weedy plants have invaded North America (NIEMELÄ / MATTSON 1996). More than half of the 2,000 immigrant insect species in the United States and Canada are of the western Palearctic (European) origin. Of the nearly 400 immigrant species that live on trees and shrubs in North America, 75% are from Europe (MATTSON *et al.* 1994). This high propor-

tion of European-origin insects is explained in part by the high intensity of trade and human dispersal between North America and Europe; furthermore, these two areas are biogeographically similar (ROHRIG / ULRICH 1991). With regard to the insect species richness in Europe and North America (i.e. Canada and the United States), which is estimated to be about the same (both roughly 100,000 species), approximately equal insect immigration in both directions can be expected, or perhaps even higher immigration to Europe due to the higher amounts of goods transported from North America. Surprisingly, recent surveys of forest entomological literature show that approximately six times as many phytophagous forest insects from Europe have successfully invaded North America than vice versa (SAILER 1983, MATTSON *et al.* 1994).

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It is known that 109 invasive insects on woody plants have established populations in European forests: 57 from North America and 52 from Asia (MATTSON *et al.* 2007). The most frequent orders account for about 84% of the species: Homoptera (39%), Lepidoptera (13%), Coleoptera (19%), and Hymenoptera (13%). The majority of these invasive species (75 of them) live on deciduous trees; the other (34 species) live on various conifers, 53% of which have also been introduced. Many introduced North American exotic species have been successful in establishing permanent populations in Europe because their native hosts preceded or accompanied them into Europe. The other reason is the mode of their reproduction (they are mostly asexually reproducing species). One of the newest aphids settling on European conifers is the bow-legged fir aphid – *Cinara curvipes* (Patch, 1912).

The first record of *C. curvipes* in Europe dates from 1999, when the bow-legged fir aphid was found in United Kingdom in the Royal Botanic Gardens at Kew, London, on twigs of *Cedrus atlantica* (MARTIN 2000, SMITH *et al.* 2007). In 2000, it appeared in continental Europe, in Germany in Brandenburg on *Abies grandis* and *A. concolor*; the aphid was later reported on *Abies koreana* in the Neuenmühle region near Schwerin, in the federal state of Mecklenburg-Vorpommern (GOTTSCHALK 2001). In 2001, colonies of *C. curvipes* were found again on *A. grandis* and on *A. concolor* in other parks and gardens of Brandenburg, Berlin and Niedersachsen (SCHEURER 2001). It was also found in Bayern, Hessen, Sachsen and Sachsen-Anhalt (SCHEURER 2001, SCHEURER *et al.* 2001, SCHEURER / FUNKE / WAURICK 2004). In Serbia, it was found in 2001 in Novi Sad on *A. concolor* and *Cedrus atlantica* (POLJAKOVIĆ-PAJNIK / PETROVIĆ-OBRAĐOVIĆ 2002). It was reported from Switzerland in 2007 in the canton of Aargau on *A. concolor* (ANGST / SCHEURER / FORSTER 2007) and from Slovakia in 2007 (NAKLÁDAL / TURČÁNI / ŠRŮTKA 2007). In the Czech Republic, the presence of *C. curvipes* was also noticed at several localities on *A. concolor* and *A. grandis* in spring 2007 (ŠRŮTKA / NAKLÁDAL / LIŠKA 2007).

In spring 2007, colonies of the bow-legged fir aphid were found on a single silver fir tree (*Abies alba*) in a private garden in Ljubljana, central Slovenia. In addition, a massive occurrence of the aphid was also noticed on *A. concolor* in the northern part of Slovenia, indicating the wide spread of the insect in Slovenia. The find is of immediate concern due to the potential economic and environmental consequences of the species' introduction. Here, we report on the charac-

teristics of the discovered species and provide an overview of the state of knowledge of this insect and its potential to cause damage.

METHODS

METODE

We searched for non-native pests and diseases in urban areas and in forests as a part of the on-going reporting, diagnostic and prognostic service for forests in Slovenia. Furthermore, Gorazd Mlinšek from the Forest Management Unit Slovenj Gradec, of the Slovenia Forest Service, reported on a heavy aphid attack on *Abies concolor* in the park of a primary school at Zgornja Muta. The school administration was concerned about the health of the tree and the influence of the heavy honeydew load on the tree and on the ground.

Photographs of aphids from *Abies alba* from a private garden in Ljubljana were taken on 26th May 2007 with a Nikon D200 camera, equipped with an AF-S MICRO Nikkor 105mm, teleconverter 1.4 and 4 SB-R200 speedlights.

Living aphids on two 100 cm-long branches of *A. concolor*, with diameters of 6.5 cm and 3.7 cm, were transferred to the Laboratory for Forest Protection in Slovenian Forestry Institute in Ljubljana on 12th December 2007.

For morphological examination, aphids were preserved in tightly-sealed tubes filled with 80-90% ethanol. After a few days, one volume of 75% w/w lactic acid was added to every two volumes of alcohol containing specimens for prolonged storage. Specimens were mounted and determined according to BLACKMAN and EASTOP, 2006. The voucher material was deposited in the BF-FOREST-Entomological collection in Ljubljana and at the Institute of Lowland Forestry and Environment in Novi Sad, Serbia.

RESULTS AND DISCUSSION

REZULTATI IN RAZPRAVA

In Slovenia, *Cinara curvipes* was found on 26th May 2007 on a grafted silver fir (*Abies alba* Mill., "Brinar") in a private garden in Ljubljana (VM60, Lat. = 46°3'23.20", Long. = 14°34'49.84", 295 m a.s.l.). The solitary tree was 14 years old, its height was 3.0 m and DBH 4.6 cm (Fig. 1, Fig. 2, Fig. 3). The variety of silver fir named "Brinar" is not described in literature and is a rare mutation with a very narrow and slender crown (BRUS 2005). Only apterous individuals were observed in one large and two small colonies.



Fig. 1: Silver fir (*Abies alba* "Brinar") attacked by *C. curvipes* in Ljubljana, 26th May 2007

Slika 1: Navadna jelka (*Abies alba* "Brinar", ki jo je napadla vrsta *C. curvipes* v Ljubljani, 26. maj 2007

The second high-level population of *C. curvipes* was reported from two trees of *Abies concolor* (Gord.) Lindl. near the primary school in Muta (WM16, Lat.= 46°36'32.18", Long.= 15° 9'44.61", 380 m a.s.l.). The solitary trees were about 60 years old, their height was 15.0 m, and DBH 27 cm. The aphids were removed by spraying with a strong jet of water and a sample was not collected. In the autumn of the 2008, one of the affected trees was cut down.

The third population of bow-legged fir aphid was found 3 km from the second location, on a tree of *A. concolor* in the park of the firm Drevesnica Omorika, near Muta on 12th December 2007 (Lat.= 46°35'55.18", Long.= 15° 9'9.68", 374 m a.s.l.). The tree was about 40 years old; its height was 15 m, DBH 18 cm. The aphids formed colonies on two lower branches, the individuals inhabiting the underside of branches of their food trees. The first colony included ca. 280 adults and the second 360 adults, with numerous instars. About 5%



Fig. 2: Thin stem of *Abies alba* "Brinar" with the colony of *C. curvipes*

Slika 2: Debelce vrste *Abies alba* "Brinar" s kolonijo uši *C. curvipes*



Fig. 3: *C. curvipes*, detail of dense feeding colony protected by ants on *A. alba* "Brinar"

Slika 3: *C. curvipes*, gosta na veji prehranjujoča se kolonija na *A. alba* "Brinar", ki jo varujejo mravlje

of adults were winged. SCHEURER and BINAZZI (2004) reported that in Central Europe, when the winter is not very cold, *C. curvipes* can survive, occupying the underside of the branches of 1.5 to 3 m high trees and also up to the upper third of the stems. On the taller trees, as in our case, the colonies are usually placed only on the underside of the branches (Fig. 4). Locations where bow-legged fir aphid was recorded in Slovenia are presented in UTM grid on map (Fig. 5).

MORPHOLOGICAL AND BIOLOGICAL NOTES

MORFOLOŠKE IN BIOLOŠKE ZNAČILNOSTI

Adult viviparous apterous females, collected on *A. concolor*, were 3.4-5.3 mm long; the colour of the dorsum of living aphids was matte dark brown to black, while some areas of



Fig. 4: Branch of *A. concolor* from underside attacked by aphids *C. curvipes*, 12th December 2007

Slika 4: Veja dolgoigličaste jelke (*A. concolor*), na spodnji strani napadena z ušmi vrste *C. curvipes*, 12. december 2007

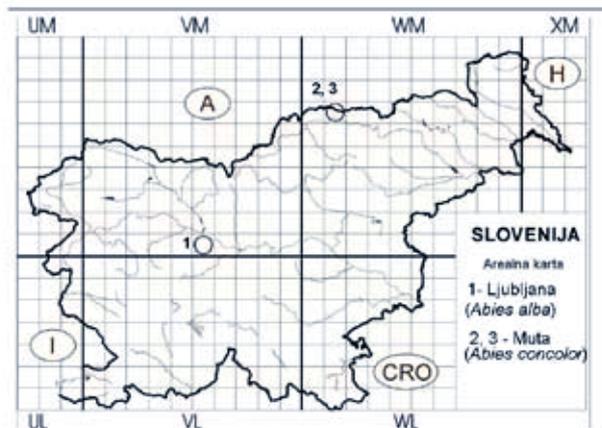


Fig. 5: Locations where *C. curvipes* was recorded

Slika 5: Lokacije najdišč vrste *C. curvipes*



Fig. 6: Apterous oviparous female with distinctive conical siphae, delivering larva

Slika 6: Nekrilata oviparna samica z različnima koničastima sifonomama, ki izlega ličinko



Fig. 7: The winged adult of *C. curvipes*

Slika 7: Krilat odrasel osebek vrste *C. curvipes*

the head, thorax and cornicles were shiny black and some of the lateral parts of the abdomen were covered with pale grey wax (Fig. 6, Fig. 8). The waxy effect is often more conspicuous in larval instars in the warmest summers or autumn days.

Apterous oviparous female had distinctive conical siphae (Fig. 6, Fig. 8). The winged adults represented 5% of the population on the third location – the park of the firm Drevesnica Omorika, near the town of Muta (Fig. 7).

Apterous oviparous females of *C. curvipes* had a large white pre-anal wax ring (Fig. 6).

Antennal segments had a basic yellowish-brown colour; the distal ends of the IV, V and VI segments were dark brown to blackish.

C. curvipes in all morphs had brown fore and middle legs; the hind femora were also brown, but with a small darker distal part (Fig. 4, Fig. 8). The tibiae of the hind legs were brownish to black but paler in the basal second fifth. The cornicles were short and shiny black on the oval sclerotised plate; the cauda was short and rounded; the rostrum, which can exceed the length of the body, was very long.

The colour of the new-born larvae was light mustard brown; their body length was about 2.25mm (Fig. 6). Some larvae, collected on December 2007, sloughed immediately after being transferred to room temperature (Fig. 9).

C. curvipes is described as myrmecophilous (MINKS / HARREWIJN 1987). We found ants *Lasius* spp. in May 2007 in Ljubljana visiting the colonies in high numbers (Fig. 3). However, the presence of parasites or predators as well as the presence of ants was not recorded in the colonies at Muta in December 2007 (probably owing to the unsuitable winter time of collecting).

The colonies of *C. curvipes* were found only in the year 2007. In the 2008, on 5th May, 6th July and on 21th October,



Fig. 8: The colour of the fore and middle legs is brown; the hind femora are brown with a darker distal part, parts of the abdomen are covered by a blue-whitish or pale grey wax powder

Slika 8: Barva sprednjih in srednjih nog je rjava, femur zadnjih nog je tudi rjav s temnejšimi distalnimi deli, deli abdomna so prekriti s svetlo modrim ali svetlo sivim voščenim poprhom

we looked for the colonies of *C. curvipes* on the same trees (*Abies alba* and *A. concolor*) in Ljubljana and Muta and in the surroundings, but without success. In 2008, we found just the aphid remnants (sloughs and dead bodies) and large amounts of sooty moulds, covering the needles and the branches of trees, which were inhabited by aphids in the previous year.

TAXONOMICAL POSITION OF CINARA CURVIPES

TAKSONOMSKI POLOŽAJ VRSTE CINARA CURVIPES

Cinara curvipes (Aphididae, Lachninae: Cinarini) is one of the aphid species from the order Homoptera, which currently numbers 4,401 species. Of these, 1,758 species from 270 genera spend all or part of their lives feeding on trees (BLACKMAN / EASTOP 2006).

The genus *Cinara* belongs to the subfamily Lachninae. The Lachninae comprises 365 species recorded globally, of which more than 200 species belong to the genus *Cinara*. About 150 species are native to North America, 38 in Europe and Mediterranean, and 20 in the Far East (HEIE 1995, BLACKMAN / EASTOP 2006). In Slovenia, 197 species from the family Aphididae have been recorded, the number of species in the subfamily Lachninae and genus *Cinara* in Slovenia is not known (MODIC / UREK 2008). There is no published work on the genus *Cinara*, but there are numerous reports on aphid honeydew producers in Slovene professional



Fig. 9: The sloughing of *C. curvipes* larva; the picture taken in the laboratory on 12th December 2007

Slika 9: Levitev ličinke *C. curvipes*, fotografirano v laboratoriju 12. decembra 2007

beekeeper (apiarist) literature. There, in total, eight species from the genus *Cinara* are quoted: *C. pilicornis* (Hartig), *C. confinis* (Koch) (= *Todolachnus abieticola* Cholodkovsky), *C. piceae* (Panzer), *C. costata* (Zetterstedt) (= *C. cistata* Buckton), *C. pruinosa* (Hartig) (= *bogdanovi* Mordvilko), *C. pectinatae* (Nördlinger), *C. pini* (Linnaeus) (as probably present in Slovenia) and *C. laricis* (Hartig) (RIHAR 2003).

Cinara curvipes morphologically resembles the European species *C. confinis* (Koch) (= *abieticola* Cholodkovsky), which in Europe feeds only on *Abies* spp. Apteræ and alatae are dark brown or greenish-black, with a double row of blackish slightly shiny spots; they are reaching the major length in the genus (3.8-7.8 mm). Another European species morphologically very similar to *C. curvipes* is *C. piceae* (Panzer) (= *grossa* Kaltenbach). Apteræ are uniformly jet black, "resembling the texture and shape of old droplets of tar" (CARTER and MASLEN 1982, after BLACKMAN / EASTOP 2006); they are 4.5 to 6.7 mm in length. *C. piceae* forms large colonies in spring on the undersides of older branches and on the trunks of *Picea* spp., and often moves to ground level or roots in summer. The most significant difference between *C. curvipes* and *C. piceae* is the length of the fourth rostral segment (*C. curvipes*: 191-252 µm; *C. piceae*: 295-375 µm) (SCHEURER / FUNKE / WAURICK 2004).

ORIGIN AND HOSTS IZVOR IN GOSTITELJI

Cinara are aphids that feed exclusively on woody parts (trunks, branches, twigs and occasionally roots) of Cupressaceae and Pinaceae conifers. Commonly known as the giant

conifer aphids, the adults range from 2 to 7.8 mm in size and are dark-coloured, long-legged insects, which are either naked or covered with a powdery wax (CIESLA 1991).

Cinara curvipes is widely distributed in many western states of the USA, also in New Hampshire, in Canada and Mexico. Inside native regions of the species, its hosts are conifers, mostly from the genus *Abies* and *Cedrus*. Colonies of this species feed on stems and branches of their hosts, but no damage to the trees has been reported so far from their native distribution area.

Cinara curvipes is a Nearctic species and common in the USA (California, Colorado, Idaho, New Hampshire, Oregon, Utah), Canada (New Brunswick) and Mexico. It occurs on the trunk or branches of *Abies* species (*Abies balsamea*, *A. concolor*, *A. grandis*, *A. lasiocarpa*, *A. magnifica* - incl. var. *shastensis* and *A. religiosa*) and occasionally on other conifers (*Cedrus deodara*, *C. atlantica* and *Juniperus* sp., *Pinus contorta*, *Picea engelmanni* and *P. glauca*) (BLACKMAN / EASTOP 2006, MARTIN 2000, ORTIZ 1982, VOEGTLIN 1976, VOEGTLIN / BRIDGES 1988, ANGST / SCHEURER / FORSTER 2007). Some authors emphasize that *C. curvipes* could appear on *Abies alba*, *A. nordmanniana*, *A. veitchii*, *Picea omorika*, *P. pungens* var. *glauca* and *Tsuga canadensis*; the report is from Germany for the year 2007 (SCHEURER 2007, in press, cit. after ANGST / SCHEURER / FORSTER 2007). Regarding the afore-mentioned data from 2007 (SCHEURER 2007, in press) about the occurrence of *C. curvipes* on *A. alba* and our finding on the same host, we can expect it to spread to silver fir forests in Slovenia. Silver fir is the third most widely distributed tree species in Slovenia. It occurs in approximately 40% of total forest area, but abundantly in less than 10%; its share in total growing stock varies between separate forest management regions, the highest reaching the altitudes between 800 and 1,000m a.s.l. Forests with silver fir are most abundant in the Dinaric and in the Pre-alpine phytogeographic regions of Slovenia (*Abieti-Fagetum dinaricum* Tregubov 1957, *Dryopterido-Abietetum* Košir 1965); they also cover the most extensive surface in the altitude belt from 1,000 to 1,200 m a.s.l. (FICKO / BONČINA 2006). In the case of spreading the aphid into these forests, we can expect our forests to be considerably affected by *C. curvipes*.

The introduction pathway of *C. curvipes* into Europe is not known; it is supposed that it was introduced with infested plant material (SCHEURER / BINAZZI 2004).

In general, *Cinara* aphids show strong host fidelity. Recent molecular phylogenetic analysis of the *Cinara* species on

pinyon pines in the southwestern USA has indicated that switching hosts played a key role in the speciation of the genus. Furthermore, species sharing a common feeding site on different hosts were more closely related to each other than to those sharing the same host but at different feeding sites. The feeding site fidelity plays a more important role in speciation than does host fidelity in general (FAVRET / VOEGTLIN 2004).

BIONOMY OF *C. CURVIPES* BIONOMIJA VRSTE *C. CURVIPES*

Cinara curvipes is a monoecious species; in America, it develops holocyclically. Palmer reported of the occurrence of both oviparous females and males from September to December in Colorado (PALMER 1952, after SCHEURER / BINAZZI 2004). In Central Europe, *C. curvipes* has an annual life cycle of six generations, with both holocyclic and anholocyclic patterns (V_1 - V_6 = parthenogenetic, fundatrices and sexuparae). In the anholocyclic life pattern, individuals of the V_4 -generation (in July) can produce offspring by parthenogenesis belonging to the virginoparous V_5 -generation, but can also give birth to oviparous females and males of the sexuales-generation in the autumn of same season. Individuals of the V_6 -generation that have a brood from the V_5 -generation up to late November have been seen to overwinter. The individuals of the overwintering V_6 -generation can migrate upwards along trees in late March and in April, sometimes reaching the base of the top shoots (the fundatrices have the same mode when emerging from the winter eggs). They start to reproduce in March, from mid April to late May (or to early June) their brood forms dense colonies of some thousand individuals and they suck on trunks and on the underside of branches. Such a phenomenon has never been previously observed in native species of *Cinara* in Central Europe. Then, the size of the colonies starts to decrease as a result of the appearance of the winged females of the V_1 and V_2 generations, which fly away to other trees. Only smaller colonies of 20 to 50 individuals can stay on host trees from the end of June to the end of August, sucking on both the trunks and the undersides of the branches, rarely on their bases. The second population peak can be reached during late summer or in autumn, from September to November; the colonies again number several hundreds of individuals (SCHEURER / FUNKE / WAURICK 2004, SCHEURER / BINAZZI 2004, CARTER / WATSON 1991). From October onwards, they move towards the base of the branches, even on their undersides, so they reduce the size of those colonies that remain on the stems and on

the upper crown. We also found the colonies on two branches on two trees of *A. concolor* at Muta on the undersides of the lower branches on 12th December. In the dense colony, aphids seem to be attached to the host tree only by both proboscis and forelegs.

Winter eggs are 1.20-1.45 mm long; at the beginning they have reddish-brown colour, later they are dark brown or black, with slight whitish waxy covering. They are attached individually to the underside of the needles, to the branches or to the stems of young trees (SCHEURER / BINAZZI 2004).

We analysed the meteorological data for the Muta location (data are from the nearest meteorological station, Slovenj Gradec, 452 m a.s.l. for the years 2007 and 2008). The average monthly temperatures for the year 2007 were 9.35°C; for the year 2008, they were 10.4°C. However, the year 2007 was very cold: the average temperatures minimum were: -3.6°C (Jan.), -1.3°C (Feb.), -0.5°C (Nov.) and -5.9°C (Dec.); absolute minimum temperatures were for the same year -11.5°C (Jan.), -8.0°C (Feb.), -4.6°C (Mar.), -2.8°C (Apr.) and -2.3°C (Oct.), -6.7°C (Nov.) and -15.5°C (Dec.); the absolute temperature maximum was 34.7°C (Jul.). In the year 2007, the amount of precipitation was 1,404 mm. In the year 2008, the average minimum temperatures were -2.0°C (Jan.), -3.5°C (Feb.) and -0.8°C (Mar.); absolute minimum temperatures were for the same year -10.0°C (Jan.), -11.3°C (Feb.), -7.4°C (Mar.) and -8.4°C (Dec.); the absolute temperature maximum was 31.6°C (May). In 2008, the amount of precipitation was 1,028mm (without data for Dec.) (Meteorological data for meteorological station Slovenj Gradec (2007/2008)). We can conclude that the year 2007 was colder than 2008, but there were not any essential differences between temperatures and precipitation in the years 2007 and 2008. The quoted low temperatures of December 2007, just some days after our collecting of the aphids, were probably the cause of the colonies disappearance.

ECONOMIC SIGNIFICANCE GOSPODARSKI POMEN

Giant conifer aphids are apparently easily transported, presumably on planting stock; some species have been introduced to areas where conifer plantations have been established and have become pests. The most notable examples are: the introduction of *Cinara cupressi* to Africa, where plantations of introduced Cupressaceae and Pinaceae are heavily damaged by the aphid (CIESLA 1991); *C. pinivora* is a serious pest on a wide range of pine species in Malawi, where it was

introduced in 2001 (CHILIMA 2004); *Cinara cronartii*, a rare species infesting stems of southern yellow pines infected with lesions or cankers of the rust fungus *Cronartium fusiforme*, was discovered in South Africa, where it has become a pest of pine plantations (KFIR *et al.* 1985, after CIESLA 1991); *C. juniperi* has been found in New Zealand (BROWNE 1968, after CIESLA 1991).

The aspect of the *Cinara* species of the greatest economic significance is that most of them excrete large amounts of honeydew, which can be an important source of food for honeybees, ants and other honeydew consumers in forest. At the individual aphid level, the amount of honeydew produced is dependent on temperature, developmental stage and the nutritional status of the host tree. At the population level, the most important factors influencing the amount of honeydew available in the phyllosphere are natural enemies and colony growth (STADLER / MICHALZIK / MÜLLER 1998). In the conifer forests of Central Europe, considering climatic change with activity increase of insects and in particular sucking insects (ROUAULT *et al.* 2006), *C. curvipes* can become an important honeydew producer. In Slovenia, this part of forest production caused by different aphids is very important (RIHAR 2003, JURC / MIKULIČ 2001). The first report on the role of *C. curvipes* as an important honeydew producer in Europe is from Slovakia (CHLEBO / KODRIK 2008).

It is known that *Cinara* species have ant-aphid mutualism, in which ants tend aphids, which in turn provide honeydew to the ants; this has been shown to affect plant growth. In boreal forests, the mutualism between wood ants (*Formica rufa* group) and *Cinara* aphids and their influence on Norway spruce growth have been investigated. They testified the influence of sucking *Cinara* aphids, which were stimulated by ants in stands of four different age classes (5, 30, 60 and 100 years) on annual radial growth. In the 30-year old stands, the mean annual radial growth of the heavily visited spruces by ants was 7.3% smaller than in trees where ant traffic was blocked; this difference was statistically significant. The mutualism had no significant effect on the radial growth in the older Norway spruce stands (60 and 100 years). This suggests that the ant-aphid mutualism may have long-term effects on tree growth (KILPELÄINEN *et al.* 2009).

The bow-legged fir aphid is considered to be a minor pest of the *Abies* species; direct damage to trees is usually not significant (ŠRŮTKA / NAKLÁDAL / LIŠKA 2007). But the report from Serbia indicated another opinion: it confirmed that *C. curvipes* can cause death of young *Abies concolor* trees (POLJA-

KOVIĆ-PAJNIK / PETROVIĆ-OBRADOVIĆ 2002). It can be noted that in Europe many species of exotic firs and other conifers are planted in parks and gardens for ornamental purposes, or for the production of Christmas trees. However, large aphid colonies can cause aesthetic damage to trees (large amounts of honeydew and development of sooty moulds) (EPPO 2008).

SUMMARY

The exotic phytophagous bow-legged fir aphid, *Cinara curvipes* (Patch, 1912) (Homoptera: Aphididae, Lachninae), was found for the first time in Slovenia in the year 2007. At first, it was found in central part of Slovenia on 26th May 2007 on a single grafted silver fir (*Abies alba* Mill., "Brinar") in a private garden in Ljubljana, secondly in the northern part of the country, in the summer 2007, on the tree of *Abies concolor* (Gord.) Lindl. in the park of the primary school at Muta and, thirdly, on a tree of *A. concolor* in the park of the firm Drevesnica Omorika, near the town of Muta on 12th December 2007. In Ljubljana, the aphids were eliminated by insecticide spray in summer 2007, while at Muta the colonies did not survive the 2007/2008 winter. It is likely that the species was introduced a few years earlier without being noticed. Interestingly, *C. curvipes* has also been introduced recently from North America to some European countries (UK, Germany, Serbia, Switzerland, Czech Republic and Slovakia). It appears on trunk or branches of *Abies* species (*Abies balsamea*, *A. concolor*, *A. grandis*, *A. lasiocarpa*, *A. magnifica* - incl. var. *shastensis* and *A. religiosa*), occasionally on other conifers (*Cedrus deodara*, *C. atlantica* and *Juniperus* sp., *Pinus contorta*, *Picea engelmanni* and *P. glauca*); recent reports cited its appearance on *Abies alba*, *A. nordmanniana*, *A. veitchii*, *Picea omorika*, *P. pungens* var. *glauca* and *Tsuga canadensis*. The current knowledge of its taxonomy, bionomy, ecology and ethology and economical significance is provided. The host fidelity of *C. curvipes*, possible switching hosts and its eventual influence on Slovene forests of silver fir (*Abies alba*) are discussed. The current status of *C. curvipes* in Slovenia is: found and disappeared. The present status *C. curvipes* in Slovenia in the year 2007 was only local, limited populations and stationary. We are expecting it to occur again, so more attention will be paid to it in the future.

POVZETEK

Tujerodna fitofagna dolgonoga jelova uš (*Cinara curvipes* [Patch, 1912]) (Homoptera: Aphididae, Lachninae) je bila v

Sloveniji prvič najdena spomladi leta 2007. Najprej je bila 26. maja 2007 ugotovljena v osrednjem delu Slovenije na drevesu navadne jelke forme »Brinar« (*Abies alba* Mill., "Brinar") v privatnem vrtu v Ljubljani, drugič je bila najdena poleti v severnem območju države v parku osnovne šole v Muti na drevesu dolgoigličaste jelke *Abies concolor* in tretjič ponovno 12. decembra na drevesu *A. concolor* v parku drevesnice Omorika v bližini Mute. V Ljubljani je bila dolgonoga jelova uš zatrita z insekticidom, na lokaciji Muta pa ni preživela zime 2007/2008. Kaže, da je bila vrsta zanesena k nam pred nekaj leti, a ni bila opažena. Pred kratkim je bila vrsta *C. curvipes* prav tako ugotovljena v nekaterih evropskih državah (Velika Britanija, Nemčija, Srbija, Švica, Češka republika, Slovaška). Pojavlja se na deblih in vejah vrst iz rodu *Abies* (*A. balsamea*, *A. concolor*, *A. grandis*, *A. lasiocarpa*, *A. magnifica* – vklj. var. *shastensis* in *A. religiosa*), občasno na drugih iglavcih (*Cedrus deodara*, *C. atlantica* in *Juniperus* sp., *Pinus contorta*, *Picea engelmanni* in *P. glauca*), novejši viri navajajo, da se pojavlja na *Abies alba*, *A. nordmanniana*, *A. veitchii*, *Picea omorika*, *P. pungens* var. *glauca* in *Tsuga canadensis*. V prispevku so podane informacije o taksonomiji, bionomiji, ekologiji in etologiji vrste *C. curvipes*, prav tako podatki o njenem gospodarskem pomenu. Obravnavana je povezanost uši z gostiteljskimi rastlinami, njen preskok na druge gostitelje in možen vpliv na naše jelove (*Abies alba*) gozdove. Trenutni status vrste *C. curvipes* v Sloveniji je, da se je pojavila lokalno, v omejenih populacijah, a njeno širjenje ni bilo opaženo. Vrsta se je pri nas v letu 2007 pojavila sporadično, a ker jo vnovič pričakujemo, bomo v prihodnjih letih ugotavljanju njene zastopanosti pri nas namenili več pozornosti.

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REFERENCES

VIRI

- ANGST, A. / SCHEURER, S. / FORSTER, B., 2007. First record of *Cinara curvipes* (Patch) (Homoptera, Aphidina, Lachnidae) on *Abies concolor* in Switzerland.- Mitteilungender Schweizerischen Entomologischen Gesellschaft 80: 247-252.
- BLACKMAN, R. L. / EASTOP, V. F., 2006. Aphids on the world's trees. An Identificational and Informational Guide.- CAB International in association with The Natural History Museum, XVI + 987 p.
- BRUS, R. 2005. Dendrology for foresters.- University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, Ljubljana, 408 p. (in Slovenian)
- CARTER, C.I. / MASLEN, N.R., 1982. Conifer lachnids.- Bull. For. Comm. Lond. No. 58, 75 p.
- CARTER, C. / WATSON, G., 1991. The ecology of conifer aphids and its bearing on forest establishment and productivity.- Workshop Proceedings. Exotic aphid pests of conifers: A crisis in African forestry. Kenya Forestry Research Institute, FAO, Rome, 160 p., <http://www.fao.org/docrep/008/u4778e/U4778E00.htm> (21.1.2009)
- CHILIMA, C.Z., 2004. A preliminary report on *Cinara pinivora* (Wilson) (Homoptera: Aphididae) a newly introduced pest of pine trees in Malawi.- Forestry Research Institute of Malawi, Limited circulation draft, 09/04, 6 p.
- CHLEBO, R. / KODRIK, J., 2008. Slovakian Honeydew Honeys – Types and Sources.- In: Apimondia International Honey Commission, 1st World Honeydew Honey Symposium, 1-3. August, 2008, Tzarevo, Bulgaria, Program and Abstracts, 34 p.
- CIESLA, W.M., 1991. The cypress aphid, *Cinara cupressi* (Buckton) in Africa.- Workshop Proceedings. Exotic aphid pests of conifers: A crisis in African forestry. Kenya Forestry Research Institute, FAO, Rome, 160 p., (<http://www.fao.org/docrep/008/u4778e/u4778e00.HTM>) (22.1.2009)
- EPPO, 2008. First report of *Cinara curvipes* (Homoptera: Aphididae) in the Czech Republic.- EPPO Reporting Service – Pests & Diseases, Paris, 2008-03-01, 2008/053 web; www.eppo-org (16.1.2009)
- FAVRET, C. / VOEGTLIN, D.J., 2004. Speciation by host-switching in pinyon *Cinara* (Insecta: Hemiptera: Aphididae).- Molecular Phylogenetics and Evolution 32, 1: 139-151.
- FICKO, A. / BONČINA, A., 2006. Silver fir (*Abies alba* Mill.) distribution in Slovenian forests.- Zbornik gozdarstva in lesarstva 79: 19-35. (in Slovenian)
- HEIE, O. E., 1995. The Aphidoidea of Fennoscandia and Denmark. VI Family Aphididae: Part 3 of tribe Macrosiphini of subfamily Aphidinae, and family Lachninae.- Fauna Entomologica Scandinavica, 31: 217.
- GOTTSCHALK, H. J., 2001. *Cinara curvipes* (Patch), Erstfund in Mecklenburg – Vorpommern, ein potentieller Forstschädling.- Mitteilungsblatt des Entomologischen Vereins Mecklenburg 1: 36.
- JURC, M. / MIKULIČ, V., 2001. Forest honeydew production and honeydew producing woody plants in the forests of Slovenia.- Gozdarski vestnik 59, 1: 18-27. (in Slovenian)
- KILPELÄINEN, J. / FINÉA, L. / NEUVONEN, S. / NIEMELÄ, P. / DOMISCH, T. / RISCH, A. C. / JURGENSEN, M.F. / OHASHI, M. / SUNDSTRÖM, L. 2009. Does the mutualism between wood ants (*Formica rufa* group) and *Cinara* aphid affect Norway spruce growth?- Forest Ecology and Management 257: 238–243.
- MARTIN, J.H., 2000. Two new British aphid introductions since 1999, in the context of other additions over the preceding thirty years (Sternorrhyncha: Aphidoidea).- Entomologist's Gazette 51, 2: 97-105.
- MATTSON, W.J. / NIEMELÄ, P. / MILLERS, I. / INGUANZO, Y., 1994. Immigrant phytophagous insects on woody plants in the United States and Canada: an annotated list.- General Technical Report NC-169. St. Paul, MN: US Department of Agriculture, North Central Forest Experiment Station, 27 p.
- MATTSON, W. / VANHANEN, H. / VETELI, T. / SIVONEN, S. / NIEMELÄ, P., 2007. Few immigrant phytophagous insects on woody plants in Europe: legacy of the European crucible?- Biological Invasions 9: 957-974.
- Metrological data for meteorological station Slovenj Gradec (2007/2008) Mesečni bilten, Agencija RS za okolje 14, 1-12.
- MINKS, A.K. / HARREWIJN, P. (eds), 1987. Aphids, their biology, natural enemies and control.- World Crop Pests 2B, Elsevier, Amsterdam, 364 p.
- MODIČ, Š. / UREK, G., 2008. Contribution to the knowledge of the aphid fauna (Sternorrhyncha: Aphidoidea) of Slovenia.- Acta entomologica Slovenica 16, 1: 87-97. (in Slovenian)
- NAKLÁDAL, O. / TURČANI, M. / ŠRŮTKA, P., 2007. First record of *Cinara curvipes* (Hemiptera: Aphididae) from Slovakia.- Klapalekiana 43: 201-202. (in Slovakian)
- NIEMELÄ, P. / MATTSON, W., 1996. Invasion of North American Forests by European Phytophagous Insects. Legacy of the European crucible?- BioScience 46 10:741-753.
- ORTIZ, M.J.P., 1982. Contribución al conocimiento de los áfidos forestales del género *Cinara* Curtis en parte del eje neovolcánico (Distrito Federal, Mexico y Michoacán).- Boletín técnico Instituto Nacional de Investigaciones forestales 78: 9-42.
- PALMER, M.A., 1952. Aphids of the Rocky Mountain Region.- Vol. 5.- Thomas Say Foundation, Denver, Colorado, 452 p.
- POLJAKOVIĆ-PAJNIK, L. / PETROVIĆ-OBRAĐOVIĆ, O., 2002. Bow-legged fir aphid *Cinara curvipes* (Patch) (Aphididae, Homoptera) new pest of *Abies concolor* in Serbia.- Acta entomologica serbica 7, 1/2: 147-150.
- RIHAR, J., 2003. Honeydew of conifers – forecast of forest honeydew production.- Ljubljana, Pansan d. o. o., 2. ed., 123 p. (in Slovenian)
- ROHRIG, E. / ULRICH, E., 1991. Ecosystems of the world. Temperate deciduous forests.- Vol. 3., New York, Elsevier, 635 p.
- ROUAULT, G. / CANDAU, J.-N. / LIEUTIER, F. / NAGELEISEN, L.-M. / MARTIN, J.-C. / 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.
- SAILER, R.I., 1983. History of insect introductions.- In: Wilson, L., Graham, CL. (eds.) Exotic plant pests and North American agriculture.- New York Academic Press: 15-38.
- SCHEURER, S., 2001. *Cinara curvipes* (Patch) - Aktualisierung und Berichtigung unseres bisherigen Wissens über die Rindenlaus.- Ameisenschutz aktuell 2:1.
- SCHEURER, S. / BINAZZI, A. / FUNKE, M. / VOEGTLIN, D.J., 2001. *Cinara curvipes* (Patch): a recently introduced species to Germany – Studies of its morphs, host plants and biology.- Sixth Intern. Symp. on Aphids, "Aphids in a New Millennium", Rennes (France), 3-7 Sept. 2001: 31.
- SCHEURER, S. / FUNKE, M. / WAURICK, M., 2004. *Cinara curvipes* (Patch) (Sternorrhyncha, Lachnidae) – neue Erkenntnisse über Morphen und Biologie dieser in Mitteleuropa vorwiegend auf *Abies grandis* und *A. concolor* saugenden Rindenlaus.- Mitteilungen Deutsche Gesellschaft für Allgemeine und Angewandte Entomologie 14: 271-276.
- 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.
- SMITH, R. M. / BAKER, R.H.A. / MALUMPHY, C.P. / HOCKLAND, S. / HAMMON, R.P. / OSTOJÁ-STARZEWSKI, J.O. / COLLINS, D.W., 2007. Recent non-native invertebrate plant pest establishments in Great Britain: origins, pathways, and trends.- Agricultural and Forest Entomology 9: 307–326.
- STADLER, B. / MICHALZIK, B. / MÜLLER, T. 1998. Linking aphid ecology with nutrient fluxes in a coniferous forests.- Ecology 79, 5: 1514-1525.
- ŠRŮTKA, P. / NAKLÁDAL, O. / LIŠKA, J., 2007. Přemnožení medovnice křivonohé *Cinara curvipes* (Patch) na okrasných jedlích v České republice.- Lesnická práce 86, 6: 25-26.
- VOEGTLIN, D. J., 1976. A biosystematic study of *Cinara* spp. (Homoptera: Aphididae) of the conifers of the West-side Sierra forests.- PhD thesis, University of California, Berkeley, 208 p.
- VOEGTLIN, D.J. / BRIDGES, C.A., 1988. Catalogue of the *Cinara* Species of North America (Homoptera: Aphidida).- Illinois Natural History Survey, Special Publication 8, 55 p.