

ORIGINAL ARTICLE

The first detection of an alien, invasive bamboo aphid species of the genus *Takecallis* (Hemiptera: Aphididae) in Poland

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Abstract

The first record of an oriental, alien aphid species belonging to the genus *Takecallis*, associated with the cold hardy bamboo *Fargesia rufa* T.P.Yi, collected in Słupsk, Pomeranian Voivodeship, Poland, is provided. The increase in worldwide trade of new frost-resistant ornamental bamboo varieties as a source of introducing alien species of insects in Europe and the role of garden centers as potential dispersal sites for these species is discussed.

Keywords: bamboo trade, *Fargesia*, pest, *Takecallis arundicolens* complex

Introduction

Bamboos are widespread fast-growing perennials with about 1662 described species in 121 genera within the subfamily Bambusoideae and family Poaceae (Canavan *et al.* 2017). These grasses are distributed worldwide, except for Europe and Antarctica, mostly in tropical and subtropical climates (Lombardo 2022). Temperate species of this subfamily from Japan and China are commonly introduced to the milder climates of Europe and Australia as ornamental plants, and some species (e.g., the running bamboos of the genus *Phyllostachys* spp.) in non-native areas have been considered invasive. Bamboo invasion alters plant species diversity and community structure. In new areas, it can negatively influence biodiversity and soil processes as well as possibly introduce associated organisms into the environment (Xu *et al.* 2020). Bamboos are subject to injury by various kinds of herbivorous arthropods, i.e., insect representatives of Diptera, Lepidoptera and Hemiptera but also spider mites (Trombidiformes) (Wang *et al.* 1998). Some of them, along with their host plants, have been introduced outside their natural range (Ostoja-

-Starzewski 2000; Pellizzari and Duso 2009; Malumphy 2012; Ülgentürk *et al.* 2014; Malumphy and Salisbury 2016).

Amongst Hemiptera, aphids (Aphididae) represent one of the most numerous introduced insects to Europe (Couer d'Acier *et al.* 2010; Mifsud *et al.* 2010). The aphid fauna of bamboo is rich, with 65 species belonging to several different subfamilies known in Asia (Blackman and Eastop 2022). However, among them, only five species were introduced into Europe: *Melanaphis bambusae* (Fullaway, 1910), *Paracolopha morrisoni* (Baker, 1919) and three species of the genus *Takecallis* Matsumura – *T. arundicolens* (Clarke, 1903), *T. arundinariae* (Essig, 1917) and *T. taiwana* (Takahashi, 1926).

The presence of their host plants limits the distribution of aphids. As small insects, they usually are introduced accidentally with their exotic host plants. Bamboo species were introduced into Europe as early as the first half of the 19th century, mainly for landscaping. In contrast, the first record of an introduced

bamboo aphid in Europe (United Kingdom) was *T. arundicolens* in 1923 (Laing 1923). Outside its natural range (Russian Far East, China, Taiwan, Korea, Japan), this aphid species was detected in North America (California: Clarke 1903, Leonard and Walker 1973; British Columbia: Maw *et al.* 2000; Florida: Halbert *et al.* 2000; Oregon: Nugent *et al.* 2005) and Africa (Algeria: Benhamaha *et al.* 2020). In Europe, this species has been found in Germany (Thieme and Eggers-Schumacher 2003), France (Leclant 1966), Ireland (Carter *et al.* 1987), Italy (Barbagallo and Cocuzza 2014); the Netherlands (Piron 2009); continental Portugal and Madeira (Aguiar *et al.* 2013), Switzerland (Lampel and Meier 2003), Serbia (Petrović-Obradović *et al.* 2018), Spain (Pons and Lumbierres 2004) and the United Kingdom (Dransfield and Brightwell 2022), where it is now widely distributed and sometimes locally abundant on various species of Bambusoideae, i.e., *Arundinaria* spp., *Bambus* spp., *Phyllostachys* spp. and *Sasa* spp. (Alford 2012). It is treated as a pest on bamboo (Quednau 2003) and was listed in the Handbook of Alien Species in Europe (Roques *et al.* 2009). Despite the growing popularity of various varieties of bamboo as an ornamental plant in Poland, no aphids of the genus *Takecallis* have been detected so far.

Materials and Methods

The discovery of the first representatives of the genus *Takecallis* in Poland was the result of a field study in 2022 and the collection of adult winged viviparous females and immatures (mostly alatoid nymphs) associated with the bamboos. The aphids were collected directly from the host plants using a fine brush and placed into Eppendorf tubes containing 70% ethanol. Adult winged females were slide-mounted using the method of Wieczorek and Chłond (2020). The slides were examined using a Nikon Ni-U light microscope equipped with a phase contrast system and photographed using a Nikon SMZ 25 stereoscopic microscope with a DS-Fi2 camera. Samples were identified based on their morphological diagnostic features using specific literature-based keys (Lee and Lee 2018; Blackman and Eastop 2022). Voucher specimens were deposited in the entomological collection of the University of Silesia, Katowice, Poland (DZUS). The botanical nomenclature was taken from the International Plant Names Index. The map was from Free Vector Maps.com.

Field photographs were taken using an iPhone 7 camera with the OlloClip Macro Pro Lens Set. The figures were prepared using Corel Draw 2021, Corel Corporation.

Results

Systematics

Class Insecta Linnaeus, 1758
Order Hemiptera Linnaeus, 1758
Suborder Sternorrhyncha Amyot et Audinet-Serville, 1843
Infraorder: Aphidomorpha Becker-Migdisova et Aizenberg, 1962
Superfamily Aphidoidea Latreille, 1802
Family Aphididae Latreille, 1802
Subfamily Calaphidinae Oestlund, 1919
Tribe Therioaphidini Börner, 1944
Genus *Takecallis* Mastumura, 1917
Species *Takecallis arundicolens* (Clarke, 1903) complex

Morphology

Color of live specimens: winged viviparous females uniformly yellow. Thoracic dorsum pale, without any stripes. Abdominal tergites pale, without any black spots. Antennae black, except for the antennal segments I-II and the very base of segment III. Cauda pale (Fig. 1A–B). Color of mounted specimens: uniformly pale with tarsi dusky and antennae black, except for the antennal segments I-II and the very base of segment III (Fig. 1C).

Host Plant

Living specimens of a viviparous generation of *T. arundicolens* complex were collected from the cold hardy bamboo variety *Fargesia rufa* T.P.Yi (Fig. 2A). The plant came from a local garden center. It had been left outside all year round for three seasons.

Bionomy

Aphids were first detected at the beginning of July 2022 on the upper side of the leaves of the host plant. Only winged adult viviparous females and numerous immatures (mostly alatoid nymphs) were observed (Fig. 2B). In summer months, the aphids were clearly visible but dispersed, not forming a solid colony and did not cause extensive direct leaf damage (Fig. 2C). The highest density of adult and immature morphs was observed at the beginning of October. Infested leaves were yellow and curled with edges covered by sooty mold colonies (black fungus) grown on the sticky honeydew excreted by aphids (Fig. 2D–E). Since neither oviparous females nor males (the sexual generation) were found in autumn, this species reproduces by anholocycly (permanent parthenogenesis), which

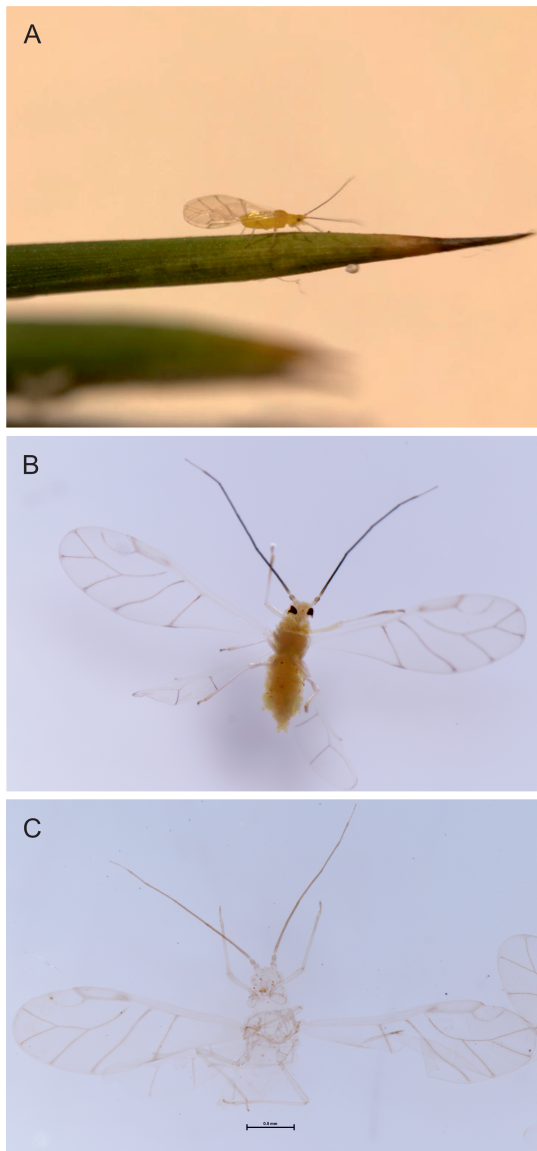


Fig. 1. Winged viviparous female *Takecallis arundicolens* complex – living (A) and mounted (B–C) specimens

generally is characteristic of introduced species of aphids.

Locality

All individuals of *T. arundicolens* complex were collected in Słupsk, Pomeranian Voivodeship, northern Poland, 54°27'52.19"N, 17°02'01.55"E. The host plant with the discovered species was in front of one of the restaurants on Michała Mostnika Street in the city center of Słupsk (Fig. 3).

Material examined

DZUS 9/7.22_1 *Takecallis arundicolens* complex, two alate viviparous females, Słupsk, Poland, 9.VII.2022, *Fargesia rufa*, K. Wiczorek leg.; DZUS 9/7.22_2 *Takecallis arundicolens* complex, two alate viviparous



Fig. 2. *Fargesia rufa*, the host plant of *Takecallis arundicolens* complex with winged adult viviparous females and numerous immatures (mostly alate nymphs) observed in July–August (B–C). The high density of adults and immatures was observed at the beginning of October. Infested leaves were yellow and curled with edges covered by sooty mold colonies (D–E)

females, Słupsk, Poland, 9.VII.2022, *Fargesia rufa*, K. Wiczorek leg.; DZUS 1/8.22_3 *Takecallis arundicolens* complex, two alate viviparous females, two alate nymphs, Słupsk, Poland, 1.VIII.2022, *Fargesia rufa*, K. Wiczorek leg.; DZUS 1/8.22_4 *Takecallis arundicolens* complex, six alate viviparous females, Słupsk, Poland, 1.VIII.2022, *Fargesia rufa*, K. Wiczorek leg.; DZUS 3/10.22_5 *Takecallis arundicolens* complex, four alate viviparous females, two alate nymphs, Słupsk, Poland, 3.X.2022, *Fargesia rufa*, K. Wiczorek leg.; DZUS 3/10.22_6 *Takecallis arundicolens* complex, four alate viviparous females, one alate nymph, Słupsk, Poland, 3.X.2022, *Fargesia rufa*, K. Wiczorek leg.

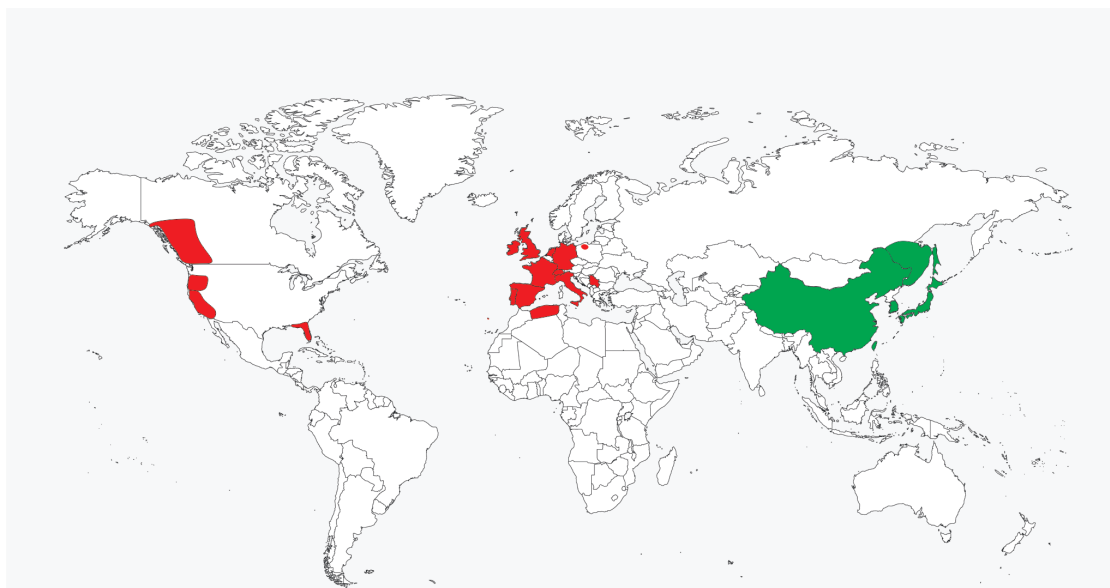


Fig. 3. Distribution map of *Takecallis arundicolens* complex: natural range – green area, introduced range – red area

Remarks

The three species of *Takecallis* introduced into Europe (*T. arundicolens*, *T. arundinariae* and *T. taiwana*) are easily distinguishable (Lee and Lee 2018; Blackman and Eastop 2022). However, DNA barcoding suggests differences between specimens from European and Asian populations of *T. arundicolens*, which indicates that there is more than one species under this name and it is treated as a species complex (Lee *et al.* 2017). Morphologically, *T. arundicolens* is characterized by a lack of dorsal abdominal markings, the black cauda and variegated antennae with 5–10 elliptical secondary rhinaria distributed on the proximal quarter of the III antennal segment. The body length is 1.8–2.8 mm (Lee and Lee 2018).

Material collected in Słupsk morphologically resembles individuals from Wales (Llandaff, Cardiff, July 2020) described by Dransfield and Brightwell (2022) as a ‘black antenna form’ of *T. arundicolens* from *Fargesia* bamboo, rather than typically described *T. arundicolens*. However, the authors conclude that the Welsh population is a variant clone of *T. arundicolens*. On the other hand, Stapleton (2022) indicated that in the United Kingdom (from 2015) also the black antenna species of *Takecallis* is spreading quickly. It is different and smaller than *T. arundicolens* (the body length specimens collected in Słupsk were 1.28–1.47 mm). Confirmation if collected during this study species is a color variant or different species from *T. arundicolens* needs further investigation. Nevertheless, it is the first representative of the genus *Takecallis* found in Poland and the country’s first alien aphid species tropically associated with bamboo.

Discussion

Aphids are among the most dangerous and common pests of economic importance (van Emden and Harrington 2017). Among them, species of non-native origin play a special role (Couer d’Acier *et al.* 2010). About 110 alien aphid species have been identified in Europe (Wieczorek 2022). Their number continuously increases due to the globalization of trade in plants and plant material, together with climate change. Although alien species are of great interest, their research status varies between European countries. The first record of alien species in the Polish aphid fauna was the green peach aphid *Myzus (Nectarosiphon) persicae* (Sulzer), recorded in 1866 (Wieczorek 2011). The latest record is the bamboo aphid, collected in 2022. Thus, almost 50 foreign aphid species have been found in Poland, accounting for about half of all identified species of alien aphids in Europe.

Bamboo is a very important resource with multiple economic and ecological values due to its great versatility as wood, food, fuel, conservation, landscape and ornamental uses (Mera and Xu 2014). So far, species of aphids associated with Bambusoidea outside their natural range were restricted to artificial habitats such as greenhouses, glasshouses, nurseries, botanical gardens, parks and gardens in city areas. Among them, botanical gardens have a key role in establishing alien aphid species, as reported by Pérez Hidalgo *et al.* (2015), Rakhshani *et al.* (2017) or Wieczorek *et al.* (2019).

At the beginning of the 19th century, over 100 different bamboo species were found in European collections following the first introduction of *Phyllostachys*

nigra (Lodd. ex Lindl.) Munro (Black Bamboo) in 1827. The first half of the 20th century saw the destruction of most European bamboo collections (except for those remaining in botanical gardens). Four types of bamboo were most commonly available in gardens: *Fargesia murielae* (Gamble) T.P.Yi (Umbrella Bamboo) and *F. nitida* (Mitford) Keng f ex T.P.Yi (Fountain Bamboo) representing the clumping type of bamboos as well as *Phyllostachys aurea* Carrière ex Rivière & C. Rivière (Golden Bamboo) and *Pseudosasa japonica* (Nakai) M. Kim (Arrow Bamboo), belonging to a running type of bamboo. In the eighties and nineties of the 20th century, large-scale flowering of *Fargesia* species destroyed its European population and prompted collectors to search for bamboo that could replace them. Thus, at least four new varieties of *Fargesia* were introduced into Europe. Among them, *F. rufa* has been present in nurseries and garden centers on a large scale and has become widely available since 2000 (Gielis and Oprins 2009).

As bamboo has unique ornamental and aesthetic values, the increase in the worldwide trade of ornamental bamboo will probably contribute to the further introduction of associated insects. In particular, a more recent introduction of frost-resistant varieties of bamboo (e.g., *Fargesia* spp.), frequently found in garden centers, may introduce alien insect species, including aphids, and spread them to our part of Europe, also due to climate warming. The obtained results seem to confirm this – the northernmost species locality of the exotic, oriental genus *Takecallis* in continental Europe was found. In low numbers, aphids rarely cause significant damage to bamboo, but when their numbers grow, severe damage may result (Stapleton 2022). This can be troublesome for decorative specimens planted in home gardens and large-hectare bamboo plantations, which are becoming more common in various parts of Europe (Lombardo 2022). Thus, it is most important to implement policies and management techniques to prevent and control these potential invasions of insect species (including aphids) of non-native origin by carefully examining all imported bamboo material, particularly distributed by garden centers. More intensive surveys on ornamental bamboo in these places and parks, gardens and nurseries will surely lead to further records, providing a better understanding of the distribution and establishment of alien species of aphids in our region.

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