

New parasitoids of *Corythucha arcuata* (Say) (Hemiptera: Tingidae) in Bulgaria

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Abstract

During the period 2019-2020, parasitoids of invasive oak lace bug (*Corythucha arcuata*) were studied in Bulgaria. Biological material (larvae of *C. arcuata*) was collected from European oak (*Quercus robur*) or Austrian oak (*Quercus cerris*) in five localities of the country. Five eulophid specimens (Hymenoptera: Eulophidae) were reared from the host larvae: *Tamarixia pubescens*, *Elasmus* sp., *Minotetrastichus* sp., *Pnigalio* sp. and *Sympiesis* sp. The impact of the parasitoids on the host number was very low (0.1-0.3%). The present records in Bulgaria are the first documented case of adaptation of native parasitoids to the host in the newly occupied areas in Europe and Asia.

Keywords

Oak lace bug, parasitoids, Eulophidae, *Tamarixia pubescens*, Bulgaria

Introduction

The oak lace bug, *Corythucha arcuata* (Say, 1832) (Hemiptera: Tingidae) is widely distributed in North America (eastern part of the USA and southern Canada). In its native range, the species feeds on leaves of different oaks (*Quercus* spp.) and occasionally on *Castanea*, *Acer*, *Pyrus*, *Malus* and *Rosa* (Drake, Ruhoff, 1965; Drew, Arnold, 1977). This invasive species has been first recorded in Italy (2000) (Bernardinelli,

Zandigiacomo, 2000), Switzerland (2002) (Forster et al., 2005) and the Asiatic part of Turkey (2002) (Mutun, 2003). In 2012, *C. arcuata* penetrated the Balkan Peninsula in Bulgaria (Dobрева et al., 2013). Recently, it has subsequently spread rapidly and caused damage in oak stands in many European countries (Csóka et al., 2019). Until now, no parasitoids of the host have been established in the expanded range of *C. arcuata* in Europe and Asia.

This note reports *Tamarixia pubescens* (Nees, 1834) (Hymenoptera: Eulophidae) as a new parasitoid of *C. arcuata* in Bulgaria.

Material and methods

The samples (leaves with *C. arcuata* larvae) were collected in 2019 and 2020 from European oak (*Quercus robur* L.) and Austrian oak (*Quercus cerris* L.) in four localities in Bulgaria (Table 1). After collection, the larvae on leaf laminae were placed individually in Petri dishes. They were kept in a laboratory at room temperatures (20-22 °C). The samples were observed weekly.

Table 1. Main characteristics of studied sites and biological material collected

Site	Coordinates	Altitude, m	Host plant	Date of collection	Larval groups, N
Sofia	42°37'41.6"N 23°21'08.8"E	650	<i>Quercus robur</i>	19 August 2019	15
Pleven	43°23'17.5"N 24°37'18.5"E	137	<i>Quercus cerris</i>	13 June 2020	25
Chirpan	42°12'04.1"N 25°20'08.6"E	197	<i>Quercus cerris</i>	28 June 2020	12
Borovan	43°23'31.7"N 23°43'15.5"E	227	<i>Quercus cerris</i>	05 Jul 2020	9

The parasitoids that emerged were identified by the keys of Peck et al. (1964), Triapitsyn (1978), Triapitsyn, Kostyukov (1978), Storozheva (1982) and Graham (1987, 1991, 1995).

The specimens were examined under an Olympus SZ51 stereomicroscope and photographed using a Leica EZ4 W stereomicroscope supplied with a WiFi CMOS still camera. All photos were processed by Zerene Stacker and were subsequently edited by manually combining adjusting and cleaning in Adobe Photoshop.

The studied parasitoid specimens are kept in the entomological collection of the University of Plovdiv 'Paisii Hilendarski'.

Results

In this study, five eulophid specimens (Hymenoptera: Eulophidae) were reared as parasitoids from the larvae of *C. arcuata*: *Tamarixia pubescens* (Nees, 1834), *Elasmus* sp., *Minotetrastichus* sp., *Pnigalio* sp. and *Sympiesis* sp. (Table 2, Fig. 1).

Table 2. Emerged parasitoids

Species	Site	Emerged parasitoids	Emergence date	Parasitism, %
<i>Tamarixia pubescens</i>	Sofia	1 ♀	25 November 2019	0.3
<i>Pnigalio</i> sp.	Sofia	1 ♂	25 October 2020	0.1
<i>Sympiesis</i> sp.	Pleven	1 ♀	27 June 2020	0.1
<i>Minotetrastichus</i> sp.	Chirpan	1 ♀	14 July 2020	0.3
<i>Elasmus</i> sp.	Borovan	1 ♂	03 August 2020	0.2

Only single parasitoid specimens were established, and the impact of the parasitoids on the host number was very low (0.1-0.3%) (Table 2).

The body length of the reared specimen of *T. pubescens* was 0.88 mm (Fig. 1A).

Discussion

There is insufficient knowledge about specific natural enemies of *C. arcuata* not only in Europe and Asia but also in its native range in North America. Recently, *Erythmelus klopomor* Triapitsyn, 2007 (Hymenoptera: Mymaridae) was described as an egg parasitoid of the host in the region of Missouri in the USA (Triapitsyn et al., 2007; Putler et al., 2014). Latter, *E. klopomor* has been reared from *C. arcuata* and other tingid hosts in Florida, North Carolina, and Maryland: *Corythucha cydoniae* (Fitch), *C. marmorata* (Uhler), *C. pergandei* Heidemann, *C. ciliata* (Say), *Gargaphia solani* Heidemann and *Pseudacysta perseae* (Heidemann) (Triapitsyn et al., 2007; Peña et al., 2009). The representatives of the *Erythmelus* genus are well known as parasitoids of heteropteran hosts, mainly from the Miridae and Tingidae families (Triapitsyn, 2003).

Tamarixia pubescens is a Transpalearctic species, distributed in many European countries (Bulgaria, Czech Republic, France, Germany, Hungary, Ireland, Italy, Romania, Serbia, Slovakia, Sweden, United Kingdom) and the People's Republic of China (Guangxi Region) (Noyes, 2019). In Bulgaria, it was found in Rila Mt. (Borovets Chaillet) and the Western Rhodopes (Rhozen loc.) (Boyadzhiev 1999, 2006). The species is known as a parasitoid of psyllids *Trioza remota* Foerster, 1848 and *Trichoermes walker* (Foerster, 1848) (Hemiptera: Triozidae) (Noyes 2019), in which its body size is 1.1-1.3 mm (Graham, 1991). In this study, the smaller size of the *T. pubescens* specimen most probably is an indication of its adaptation to the new host, *C. arcuata*.

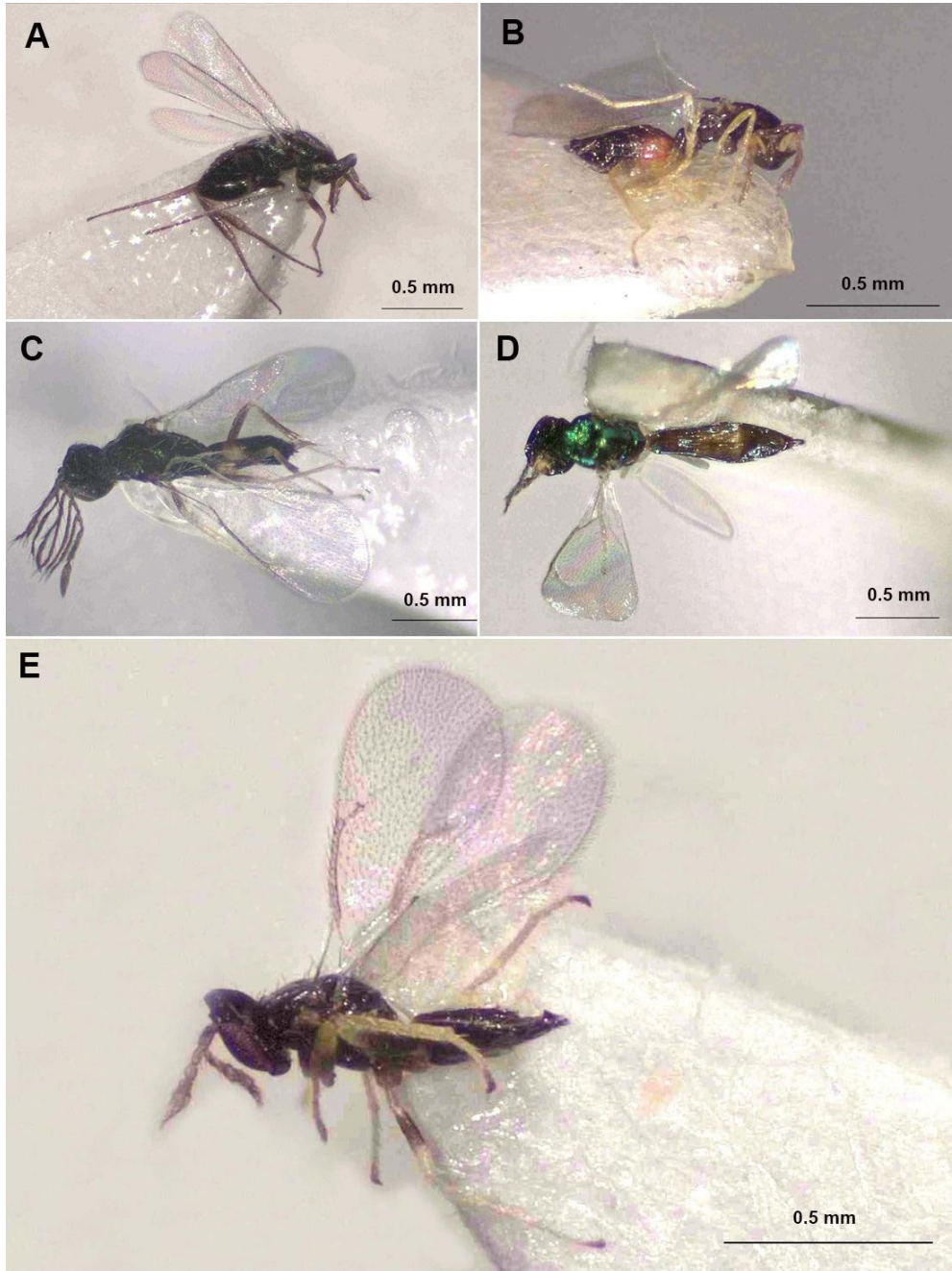


Figure 1. Parasitoids of *Coithucha arcuata*: A – *Elasmus* sp.; B – *Minotetrastichus* sp.; C – *Pnigalio* sp.; D – *Sympiesis* sp.; E – *Tamarixia pubescens*

The species of the genus *Elasmus* are mostly parasitoids or hyperparasitoids of lepidopteran or hymenopteran larvae (Strakhova et al., 2011). Recent data indicate that their hosts belong to the orders Coleoptera, Diptera, Hemiptera, Hymenoptera and Lepidoptera (Noyes, 2019).

The representatives of *Minotetrastichus* genus are known as parasitoids on leaf-mining lepidopteran, coleopteran and hymenopteran hosts (Noyes, 2019).

The species of the *Pnigalio* genus are primary parasitoids of phytophagous coleopteran, dipteran, hymenopteran and lepidopteran hosts, as well as hymenopteran parasitoids (Braconidae and Eulophidae) (Noyes, 2019).

The representatives of the *Sympiesis* genus are associated with phytophagous hosts from the orders Coleoptera, Diptera, Hemiptera (Coccidae), Hymenoptera and Lepidoptera, and parasitoids of the families Tachinidae, Braconidae and Eulophidae (Noyes, 2019).

In conclusion, the present records in Bulgaria are the first observed cases of parasitism on *C. arcuata* in Europe and Asia. Other cases of adaptation of native parasitoid species to the oak lace bug should be also expected in newly occupied areas.

Acknowledgments

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