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New grape-feeding leafhoppers in Hungary – first records of *Erasmoneura vulnerata* (Fitch, 1851) and *Arboridia kakogawana* (Matsumura, 1931) (Hemiptera: Clypeorrhyncha: Cicadellidae)

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Abstract – *Erasmoneura vulnerata* (Fitch, 1956) and *Arboridia kakogawana* (Matsumura, 1931) (Hemiptera: Clypeorrhycha: Cicadellidae: Typhlocybinae: Erythroneurini) are reported from Hungary for the first time.

Key words – pests, grapevine, introduced species, new records, distribution

INTRODUCTION

The Auchenorrhyncha (Hemiptera) fauna of Hungary is steadily increasing due to active research; however, in the last decades several non-native species invaded the country, mostly by human-mediated spread (Koczor *et al.* 2012). In Hungary, eight exotic species have been recorded so far; further seven species are native in Europe (mainly in the Mediterranean) and their recent reports from Hungary are most probably due to natural spread facilitated by climate change (Table 1).

Viticulture in Hungary has a long history and plays an important role in the Hungarian culture, therefore, grapevine-associated insects have a significant influence in the country. In 2023, during autumn and winter, several investigations were conducted in Hungary, mainly in Budapest and Kaposvár, to monitor overwintering auchenorrhynchan species, especially on evergreen bushes. The main purpose of the investigations was to find the invasive alien species *Hishimonus hamatus* Kuoh, 1976 which was recently recorded from Hungary

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(Orosz *et al.* 2024). During the field work two other non-native species, hitherto undetected in Hungary, have been found, namely *Erasmoneura vulnerata* (Fitch, 1851), and *Arboridia kakogawana* (Matsumura, 1931) (Table 1).

The genus *Erasmoneura* Young, 1952 comprises 14 valid species which are all native to North America (Dmitriev & Dietrich 2007). None of the species have been found in Hungary so far.

The genus *Arboridia* Zakhvatkin, 1946 includes more than 80 species, 19 of which are native to Europe (Jong 2016). In Hungary five species have been reported: *Arboridia erecta* (Ribaut, 1931), *Arboridia parvula* (Boheman, 1845), *Arboridia pusilla* (Ribaut, 1936), *Arboridia ribauti* (Ossiannilsson, 1937) and *Arboridia velata* (Ribaut, 1952) (Györffy *et al.* 2009). *Arboridia* species, just like other members of the tribe Erythroneurini, feed on the mesophyll tissue of leaves, mostly on the lower surface. There are some grapevine-associated species in both genera, some of them of high importance. Both species reported here as new to Hungary are grapevine pests (Dmitriev & Dietrich 2007).

MATERIAL AND METHODS

Erasmoneura vulnerata was found in October 2023 in Tiszafüred by sweeping *Taxus baccata* L. (Taxaceae) and *Thuja occidentalis* L. (Cupressaceae). The species was collected in high numbers, together with a single specimen of *Arboridia kakogawana*, in the Botanical Garden of Soroksár, Budapest, in November of the same year by sweeping the same evergreen bushes. A targeted search revealed the presence of *Erasmoneura vulnerata* in Gödöllő and in the National Botanical Garden of Hungary in Vácrátót. Searching on a Hungarian citizen science website (izeltlabuak.hu) for recording arthropod species, the earliest evidence for the presence of *Erasmoneura vulnerata* was found to be a photo of the species taken on 8.IX.2022 in Domaszék** by the second author: it was observed under artificial light (white LED (4000 K) and UV-LED (395nm)) at night. On 21.X.2022 it was found on a leaf of *Ambrosia artemisiifolia* L. (Asteraceae)***. One specimen of *Erasmoneura vulnerata* (a sunbathing individual from the white wall of Grassalkovich Calvary, Erzsébet Park, Gödöllő) was captured and donated by Gergő Tamási.

Identifications were made using a Leica MZ 95 stereomicroscope, and photographs were taken using a Raynox Super Macro Conversion Lens DCR-250 adapter set on a Nikon D 7200 digital camera. All voucher specimens are deposited in the Hemiptera Collection of the Hungarian Natural History Museum, Budapest (HNHM).

** https://www.izeltlabuak.hu/talalat/431358

*** https://www.izeltlabuak.hu/talalat/327095

Table 1. Non-native auchenorrhynchan species reported from Hungary

Origin	**Family**	**Species**	**First Hungarian record** collected (published)
Nearctic	Membracidae	*Stictocephala bisonia* Kopp & Yonke, 1977	1912 (Horváth 1912)
	Flatidae	*Metcalfa pruinosa* (Say, 1830)	2004 (Pénzes 2004)
	Cicadellidae	*Scaphoideus titanus* Ball, 1932	2006 (Dér *et al*. 2007)
	Acanaloniidae	*Acanalonia conica* (Say, 1830)	2016 (Kóbor *et al*. 2021)
	Cicadellidae	*Erasmoneura vulnerata* (Fitch, 1851)	2023 (present study)
Eastern Palaearctic	Cicadellidae	*Japananus hyalinus* (Osborn, 1900)	1987 (Lauterer 1989)
	Cicadellidae	*Orienthus ishidae* (Matsumura, 1902)	2011 (Koczor *et al*. 2013)
	Cicadellidae	*Tautoneura polymitusa* Oh & Jung, 2016	2012 (Tóth *et al*. 2017)
	Cicadellidae	*Hishimonus hamatus* Kuoh, 1976	2021 (Orosz *et al*. 2023)
	Cicadellidae	*Arboridia kakogawana* (Matsumura, 1931)	2023 (present study)
Western Palaearctic	Cicadellidae	*Fruticidia bisignata* (Mulsant & Rey 1855)	2008 (Orosz 2009)
	Cicadellidae	*Liguropia juniperi* (Lethierry, 1876)	2009 (Koczor *et al*. 2012)
	Cicadellidae	*Pagiphora annulata* (Brullé, 1832)	2010 (Koczor *et al*. 2011)
	Cicadellidae	*Synophropsis lauri* (Horváth, 1897)	2011 (Korányi *et al*. 2018)
	Cicadellidae	*Latilica maculipes* (Melichar, 1906)	2012 (Korányi *et al*. 2018)
	Cicadellidae	*Eupteryx decemnotata* Rey, 1891	2021 (Tóth & Ronkay 2023)
	Cicadellidae	*Opsius smaragdinus* Emeljanov, 1964	2009 (Koczor *et al*. 2012)

RESULTS AND DISCUSSION

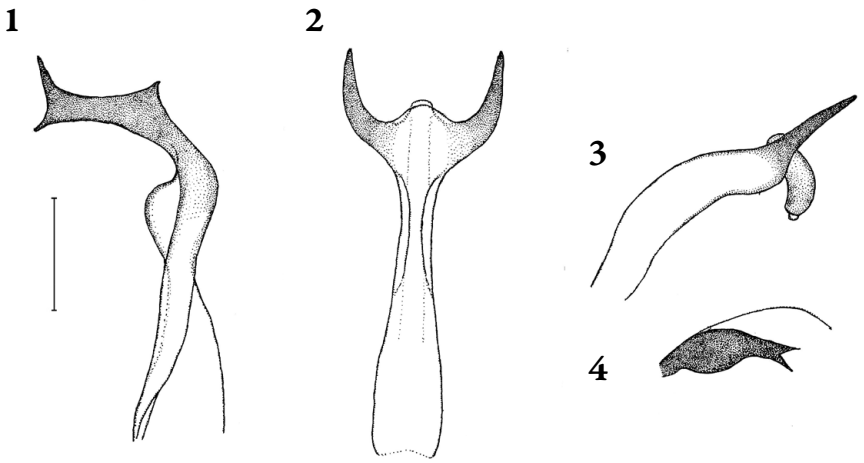
Erasmoneura vulnerata (Fitch, 1851)
(Figs 1–4, 10)

Material examined – Hungary: Tiszafüred, park of Kemény Castle, 9.X.2023, leg. B. Schlitt (3 males, 9 females); Budapest, Soroksár Botanical Garden, 25.XI.2023, leg. B. Schlitt & A. Orosz (20 males, 18 females); 10.II.2024, leg. B. Schlitt & A. Orosz (3 males, 1 female); Budapest, ELTE Botanical Garden, 22.II.2024, leg. A. Orosz (2 males, 3 females); Vácrátót, National Garden of Hungary, 17.II.2024, leg. B. Schlitt & A. Orosz (4 males, 2 females); Gödöllő, Erzsébet Park, 8.II.2024, leg. G. Tamási (1 female).

Identification – The species can easily be recognised due to its orange-brownish body decorated with white spots and lines. Its vertex is sharply angled, with elongate, usually whitish spots surrounded by orange. The wax plate of fore wing is extensive, off-white, with a bluish dark patch ending with the characteristic reddish R1 vein, apical cells are dusky with white crossveins and spots (Beamer 1946). Male genitalia were illustrated by Beamer (1946), Dmitriev & Dietrich (2007) and Seljak (2011); additional drawings are provided based on specimens examined in course of the present study (Figs 1–4). Nymphs are dorsoventrally flattened, ground colour of dorsum is reddish brown with diffuse, marmorate spots and with a median longitudinal yellow band (Rizzoli *et al.* 2020).

Various authors (e.g., Tomov 2022) recorded two seasonal forms of the species: the autumn form, with body colouration faded, mainly green and white, and R1 vein whitish; and the summer form, with body colouration more distinctly contrasting, orange-brown, and R1 vein red. No polychromism was observed in specimens from Hungary; all overwintering specimens collected from November to February were distinctly coloured, with distinctive red R1 vein, thus corresponding with the summer form.

Distribution – First records from Hungary. The species is native to the USA, Canada and Mexico (Dmitriev & Dietrich 2007). Its first occurrence in Europe was detected in 2004, in the Veneto Region of north-eastern Italy (Duso *et al.* 2005). The species subsequently spread all over northern Italy (Duso *et al.* 2019). It was found in Slovenia around Nova Gorica, close to the northeastern boundary of Italy, in 2010 (Seljak 2011). A survey conducted in 13 vine plantations situated in Romania (Odobești, Panciu, Cotești and Huși) between 2016 and 2019 detected several individuals in 2018, but specimens had been observed in the country already in 2015 (Chireceanu *et al.* 2020). Most recently it was reported from vineyards in Ticino, southern Switzerland (Rizzoli *et al.* 2020), in the vicinity of the Belgrade Customs Office Terminal in Serbia (Sciban & Kosovac 2020), and in Ruse and Svishtov in Bulgaria (Tomov 2022). The present study reports specimens from six different localities in Hungary.



Figs 1–4. Structure of the male genitalia of *Erasmoneura vulnerata* (Fitch, 1851), 1 = stylus, 2 = aedeagus (dorsal view), 3 = aedeagus (lateral view), 4 = dorsal appendage of pygofer lobe. Scale bar = 100 μm (drawings by András Orosz)

Host plants – *Vitis vinifera* L. (and cultivars), *Vitis labrusca* L. (and cultivars), *Vitis riparia* Michx., *Parthenocissus quinquefolia* (L.) Planch., *Parthenocissus tricuspidata* (Siebold & Zucc.) Planch. (all Vitaceae), *Cercis siliquastrum* L. (Fabaceae) (Duso *et al.* 2005, Seljak 2011)

Life cycle – The species is mainly associated with *Vitis* spp., other host plants are recognised as secondary (Duso *et al.* 2019). It usually produces two generations per year, although a third generation occurs under favourable conditions (Duso *et al.* 2020). Adults leave their overwintering sites and colonise grapevines at the bud burst. According to Duso *et al.* (2019) the distance between the overwintering site and grapevine yards is an important factor influencing the population size of *Erasmoneura vulnerata*.

The species overwinters among plant debris and leaves, primarily of *Quercus* (Fagaceae) and *Betula* (Betulaceae) (Duso *et al.* 2005). Investigations in Hungary show that the species also uses the evergreen species *Taxus baccata* and *Thuja occidentalis* as shelter plants. The thick foliage of these plants apparently offers good shelter for numerous species of overwintering leafhoppers, for example *Zygina* spp., *Arboridia* spp., *Hebata* spp., which were collected with individuals of *Erasmoneura vulnerata*. Empoascini and Erythroneurini were particularly abundant on these evergreens. These plants may provide more safety from predators and biological or physical threats (e.g., mold contamination, compression).

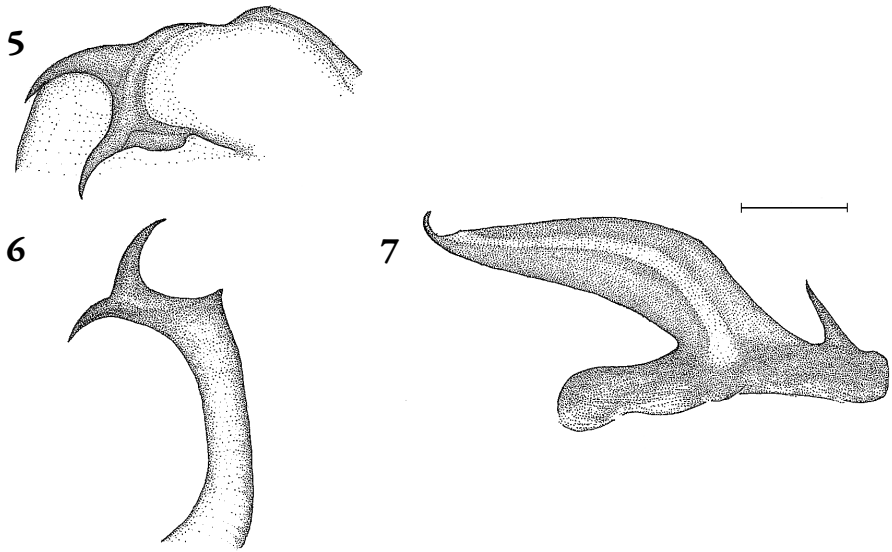
Economic importance – Feeding of adults and nymphs of *Erasmoneura vulnerata* from the mesophyll causes necrosis resulting in pale speckled areas around the feeding spots. In the case of an abundant population, the necrotic points can overlap and cover the entire surface of the leaf. Leaves are frequently contaminated by black excrement (Paxton & Thorvilson 1996). These symptoms decrease the assimilation surface of leaves, and the heavily infested leaves are frequently curled, scorched, and they may fall off prematurely. The first generation of nymphs usually does not cause significant harm, whereas the second generation is more destructive due to their high population number (Prazaru *et al*. 2021). The third generation, if present, may also cause a considerable harm to the plants (Tomov 2022). Prazaru *et al.* (2021) claimed that the presence of adults of *Erasmoneura vulnerata* in the vineyard is inconvenient for grape-pickers during harvest because of their hopping activity.

In the early 20th century *Erasmoneura vulnerata* was recognised as a significant pest of grapevine in America (Robinson 1926), but detailed studies demonstrated that it does not dominate the leafhopper communities of American grapevine yards; therefore, recent authors consider it as a secondary pest of grapevine (Zimmerman *et al.* 1996, Paxton & Thorvilson 1996). The population introduced to Europe apparently causes a more severe damage. For example, in Italy it was found to dominate the leafhopper aggregations and cause serious losses both to commercial and organic vineyards, irrespectively of attempts of control using common insecticides (Duso *et al.* 2020). Hungarian farmers should be aware of the presence of the species and further monitoring is needed regarding the distribution, life cycle and damage of *Erasmoneura vulnerata* in Hungary.

Arboridia kakogawana (Matsumura, 1931)
(Figs 5–9)

Material examined – Hungary: Budapest, Soroksár Botanical Garden, 25.XI.2023, leg. B. Schlitt & A. Orosz (1 male).

Identification – The species is rather similar to other *Arboridia* species. The single specimen collected in Hungary is reddish orange, the spots of fore wings are blurred and reach the subcostal area, the apical cells are dusky, the spots of pronotum are pale or absent. A bright yellowish form of the species is also known, lacking any distinctive orange or brown markings of fore wings (Chireceanu *et al.* 2019). Reliable identification of *Arboridia kakogawana* is only possible based on the male genitalia, which were illustrated by Dworakowska (1970), Gnezdilov *et al.* (2008), Sugonyaev *et al.* (2004), Anufriev & Emeljanov (1988), and Chireceanu *et al.* (2019); drawings of male genitalia are given in Figs 5–7.



Figs 5–7. Structure of the male genitalia of *Arboridia kakogawana* (Matsumura, 1931), 5 = processes of pygofer lobe, 6 = stylus, 7 = aedeagus. Scale bar = 50 μm (drawings by András Orosz)

Figs 8–10. Adults of the species, 8–9 = *Arboridia kakogawana* (Matsumura, 1931), 10 = *Erasmoneura vulnerata* (Fitch, 1851) (photos by Anna Ágnes Somogyi)

Distribution – First record from Hungary. Native to Japan (Matsumura 1932), the Korean Peninsula (Dworakowska 1970) and the Russian Far East (Anufriev & Emeljanov 1988). The species is currently rapidly expanding its area. It was introduced to the Western Palaearctic region accidentally, perhaps via cargo ships (Gnezdilov *et al.* 2008); its first population in the Western Palaearctic was detected in Krasnodar area of southern Russia in 1999 (Gnezdilov 2000). The species was subsequently found in the Crimean Peninsula (Radionovskaya & Didenko 2014), the northern Caucasus, and in the Rostov Oblast of Russia (Balakhnina *et al.* 2009, Artokhin 2009). It was detected in the vicinity of Bucharest, Romania, in 2018, but a subsequent re-examination of material collected in the area using yellow sticky traps demonstrated that the species had been present in Romania at least since 2016 (Chireceanu *et al.* 2019). Subsequent records of the species are from Novi Sad and Srbobran, Serbia (Sciban *et al.* 2021), from eastern Ukraine (Martynov *et al.* 2019), and from Bulgaria, where it occurs mainly in the northern part of the country and the Black Sea coast (Tomov 2022). In Bulgaria the records are usually close to major roads, suggesting a probably human-mediated dispersion (Tomov 2022). In Hungary only one specimen was collected in the Botanical Garden of Soroksár.

Host plants – *Vitis vinifera* (and cultivars), *Vitis amuriensis*, *Parthenocissus quinquefolia* (Chireceanu *et al.* 2019).

Life cycle – The species inhabits broad-leaved and mixed forests and feeds on *Vitis amurensis* in the Russian Far East (Anufriev & Emeljanov 1971); nevertheless, it was recorded as a grapevine pest in Russia and South Korea (Sugonyaev *et al.* 2004, Ahn *et al.* 2005). It is polyvoltine, developing two to five generations per year depending on the geographical region (Chireceanu *et al.* 2018). Adults are active roughly from early June to September (with differences according to macroclimate), then migrate to overwintering sites (Baranets *et al.* 2022). In the Krasnodar region adults are found in middle to late May and early June, with three peaks of population (Gnezdilov 2000).

In South Korea, adults migrate from grapevine yards to nearby forests and overwinter under the bark of various trees (Ahn *et al.* 2005). Our results indicate that the species can also use the evergreens *Taxus baccata* or *Thuja occidentalis* for shelter plants.

Economic importance – *Arboridia kakogawana* can damage approximately 70 different cultivars of grapevine (Gnezdilov 2008). All developmental stages feed on *Vitis* spp., nymphs mainly between the central vein and its lateral branches. The affected tissue becomes chlorotic due to the loss of photosynthetic pigments. The trophic activity of the leafhopper also negatively affects some qualitative parameters (e.g., sugar concentration) and maturation period of the grapevine (Radionovskaya & Didenko 2015). Injuries caused by this species, however, cannot be separated from similar symptoms caused by several other, mostly introduced species including *Erasmoneura vulnerata*, *Scaphoideus titanus*,

Stictocephala bisonia (Kopp et Yonke, 1977) and *Empoasca* spp. (Sciban *et al.* 2021). Although it seems to accept all grape varieties, it is usually more abundant on cultivars with leaves of medium or intense pubescence (e.g., Cabernet Sauvignon) than on cultivars with weak pubescence or entirely glabrous leaves (e.g., Arcadia) (Baranets *et al.* 2022). The intensive trophic activity and the frequently high abundance of individuals make *Arboridia kakogawana* a significant phytosanitary risk in several countries of Europe (Chireceanu *et al.* 2019, Sciban *et al.* 2021). This is likely the situation in Hungary, with unforeseeable consequences at the present. Therefore, further research is needed about the occurrence and importance of *Arboridia kakogawana* in the country.

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