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The Central European endemic *Aradus mirus* Bergroth, 1894 (Hemiptera: Heteroptera: Aradidae): new records and review of its distribution and biology

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Abstract

Aradus mirus Bergroth, 1894 is trophically bound to native Central European species of pines, *Pinus sylvestris* and *P. nigra*, developing on dry(ing) broken-off branches lying on the ground. It inhabits various localities in warm or medium warm regions in relict pine forests as well as pine plantations in areas where relict pine stands once existed. It is the only flat bug species endemic to Central Europe, being limited to north-east Austria, north-west Hungary (a single historical record), Slovakia and the Czech Republic, and was only recently found in Germany (Thuringia; the second record reported herein) and once in southern Poland (Upper Silesia). While in Austria, Slovakia and Moravia, respectively, there is only a single record of this species in the past 30 years, it is rather frequently collected in Bohemia.

Keywords. Heteroptera, Aradidae, biology, faunistics, habitat, Austria, Czech Republic, Germany, Hungary, Poland, Slovakia, Palaearctic Region.

Zusammenfassung

Aradus mirus Bergroth, 1894 ist trophisch an einheimische, mitteleuropäische Kiefernarten, *Pinus sylvestris* und *P. nigra*, gebunden. Sie entwickelt sich auf trockenen, abgebrochenen Ästen, die am Boden liegen. Die Art besiedelt vielerlei Standorte in warmen oder mittelwarmen Regionen mit Reliktvorkommen oder Forsten mit lange bestehenden Kiefernvorkommen. Sie ist die einzige Rindenwanzenart, die endemisch in Mitteleuropa vorkommt. Ihre Verbreitung ist auf Nordost-Österreich, Nordwest-Ungarn (ein einziger historischer Nachweis), die Slowakei und Tschechien begrenzt. Erst vor kurzem wurde sie in Deutschland (Thüringen; Zweitfund in dieser Arbeit) und einmal in Südpolen (Oberschlesien) nachgewiesen. Während in Österreich, der Slowakei und Mähren jeweils nur ein einziger aktueller Nachweis dieser Art aus den letzten 30 Jahren vorliegt, wird sie in Böhmen recht häufig gesammelt.

Introduction

The flat bugs or bark bugs (Aradidae) are represented in the fauna of Central Europe (here arbitrarily understood as the area of Europe consisting of Germany, Poland, Czech Republic, Slovakia, Switzerland, Liechtenstein, Austria, and Hungary) by four subfamilies, five genera and 34 species and subspecies, with the majority of taxa – 29 species and

subspecies – belonging to the speciose genus *Aradus* Fabricius, 1803 (for review see Table 1). Most of these species represent widely distributed faunistic elements – Holarctic (*Aradus lugubris* Fallén, 1807, *A. pictellus* Kerzhner, 1973, *A. signaticornis* R. F. Sahlberg, 1848), Palaearctic (e.g., *Aneurus avenius* (Dufour, 1833), *Aradus betulae* (Linnaeus, 1758), *A. corticalis* (Linnaeus, 1758)), West Palaearctic (e.g., *Aneurus laevis* (Fabricius, 1775), *Aradus cinnamomeus* Panzer, 1806, *A. conspicuus* Herrich-Schaeffer, 1835), Euro-Siberian (e.g., *Aradus angulatus* J. Sahlberg, 1886, *A. betulinus* Fallén, 1807, *A. crenaticollis* R.F. Sahlberg, 1848, *A. erosus* Fallén, 1807) or European (e.g., *Aradus dissimilis* A. Costa, 1847, *A. krueperi* Reuter, 1884, *A. pallescens pallescens* Herrich-Schaeffer, 1840, *A. truncatus* Fieber, 1860, *Mezira tremulae tremulae* (Germar, 1822)). In addition to these widely distributed taxa, there are boreo-montane faunistic elements with their centre of distribution in the taiga forest zone of the northern Palaearctic (or Holarctic), with isolated distributions in the mountains of Central Europe, some of them being pyrophilous (e.g., *Aradus angulatus*, *A. crenaticollis*) (Heiss 2001, Heiss & Péricart 2007, Aukema et al. 2013, Gossner et al. 2018, Heiss & Scudder 2019). Four of the recorded species represent Mediterranean (*Aradus pictus* Baerensprung, 1859, *A. reuterianus* Puton, 1875), West-Mediterranean (*Quilnus marcosi* Heiss & Baena, 2006) or East-Mediterranean (*Aradosyrtis salicis* (Horváth, 1913)) elements, extending to Central Europe only marginally, mostly on the southern slopes of the Alps (Heiss 2001, 2006, 2010, Heiss & Baena 2006, Heiss & Péricart 2007, Aukema et al. 2013, Kment & Carapezza 2022). Two additional species have their center of distribution in the Mediterranean (*A. serbicus* Horváth, 1888 – Bulgaria, Croatia, France, Greece, Italy, Kosovo, North Macedonia, Serbia) or the Balkan Peninsula (*Aradus kuthyi* Horváth, 1899 – Albania, Bosnia Herzegovina, Greece), but their ranges extend into Central Europe more extensively: *Aradus serbicus* reaches as far as Hungary, Austria and Hesse in Germany, and *A. kuthyi* reaches Austria, Czech Republic, Hungary, and Slovakia (Heiss 2001, 2006, Heiss & Péricart 2007, Morkel 2010, Aukema et al. 2013). However, only one species of the Central European fauna, *Aradus mirus* Bergroth, 1894, is endemic to certain areas of this region, which has received little attention in the past (but see Rabitsch 2009). The biology, ecology and distribution of *A. mirus* are reviewed and discussed in this paper.

Material and methods

The habitus photograph of a mounted specimen was made using a Canon MP-E 65 mm macrolens attached to a Canon EOS 550D camera. The final image was stacked from multiple layers using the Helicon Focus 5.1 Pro software. All localities of the studied species were georeferenced using Google Earth ver. 10.38.0.0 (Google Inc., Mountain View, CA, USA) (geographical projection, decimal degrees, datum: WGS84). The distribution map was prepared using QGIS ver. 3.34 (QGIS Development Team, using the WGS84 datum and EPSG 3857 (Web Mercator)). Final figure processing was done using PhotoScape X 4.2.1 (photoscape.org).

The material examined is deposited in the following collections:

LBVC Lukáš Blažej private collection, Varnsdorf, Czech Republic

MNÖ Museen Niederösterreich, St. Pölten, Austria

NHMW Naturhistorisches Museum in Wien, Vienna, Austria

NMPC National Museum of the Czech Republic, Prague, Czech Republic

Tab. 1. List of Aradidae species recorded from Central Europe. State records included in Heiss (2001) are marked in black, later records in red with particular reference given in References section.

Species	Germany (GE)	Poland (PL)	Czechia (CZ)	Slovakia (SK)	Switzerland (SZ)	Liechtenstein (LS)	Austria (AU)	Hungary (HU)	References
Aneurinae Douglas & Scott, 1865									
Aneurus (*Aneurodes*) *avenius* Dufour, 1833)	■	■	■	■	■		■	■	Heiss (2003, *A. avenius tagasastei* Enderlein, 1931 upgraded to species status)
Aneurus (*Aneurus*) *laevis* (Fabricius, 1775) (= *A. laevis intermedius* Wagner, 1971)	■	■	■	■	■	■	■	■	Heiss (2003, synonymy of *A. l. intermedius*)
Aradinae Brullé, 1836									
Aradus (*Aradus*) *angularis* J. Sahlberg, 1886					■				SZ: Gossner et al. (2018)
Aradus (*Aradus*) *aterrimus* Fieber, 1864	■	■		■	■		■		AU: Eckelt in Rabitsch & Friess (2024), GE: Heiss & Péricart (2007)
Aradus (*Aradus*) *betulae* (Linnaeus, 1758)	■	■	■	■	■		■	■	
Aradus (*Aradus*) *betulinus* Fallén, 1807	■	■	■	■	■	■	■	■	
Aradus (*Aradus*) *bimaculatus* Reuter, 1872	■	■	■	■			■	■	SK: Kment et al. (2013)
Aradus (*Aradus*) *brenskei* Reuter, 1884			■	■			■	■	CZ: Kment et al. (2003)
Aradus (*Aradus*) *brevicollis* Fallén, 1807	■	■	■		?		■	■	
Aradus (*Aradus*) *cinnamomeus* Panzer, 1806	■	■	■	■	■		■	■	
Aradus (*Aradus*) *conspicuus* Herrich-Schaeffer, 1835	■	■	■	■	■		■	■	
Aradus (*Aradus*) *corticalis* (Linnaeus, 1758)	■	■	■	■	■	■	■	■	
Aradus (*Aradus*) *crenaticollis* R.F. Sahlberg, 1848	■		■		■		■		CZ: Kment et al. (2003)
Aradus (*Aradus*) *depressus depressus* (Fabricius, 1794)	■	■	■	■	■	■	■	■	
Aradus (*Aradus*) *dissimilis* A. Costa, 1847 (= *A. dissimilis alpinus* Seidenstücker, 1952)	■						■		Heiss (2004, synonymy of *A. d. alpinus*)
Aradus (*Aradus*) *distinctus* Fieber, 1860	■		■	■			■	■	
Aradus (*Aradus*) *erosus* Fallén, 1807	■	■	■	■		■	■		
Aradus (*Aradus*) *krueperi* Reuter, 1884	■		■		■		■	■	GE: Günther (2008), SZ: Hollier (2012)

Species	Germany (GE)	Poland (PL)	Czechia (CZ)	Slovakia (SK)	Switzerland (SZ)	Liechtenstein (LS)	Austria (AU)	Hungary (HU)	References
Aradus (*Aradus*) *kuthyi* Horváth, 1899			■	■			■	■	
Aradus (*Aradus*) *lugubris* Fallén, 1807	■	■	■	■	■		■	■	
Aradus (*Aradus*) *mirus* Bergroth, 1894	■	■	■	■			■	■	GE: Küssner (2021), PL: Gierlasiński & Regner (2018)
Aradus (*Aradus*) *pallescens frigidus* Kiritshenko, 1913	■				■		■		GE, SZ: Heiss & Péricart (2007); Heiss (2004, downgraded to subspecies of *A. pallescens*)
Aradus (*Aradus*) *pallescens pallescens* Herrich-Schaeffer, 1840	■		■	?	■		■	■	
Aradus (*Aradus*) *pictellus* Kerzhner, 1973 (= *A.* (*A.*) *obtectus* Vásárhelyi, 1988	■	■	■	■	■		■	■	HU, SZ: Heiss & Péricart (2007); Heiss & Scudder (2019, synon. of *A. obtectus*)
Aradus (*Aradus*) *pictus* Baerensprung, 1859							■		Records CZ?, SK?, SZ? in Heiss (2001) and Aukema (2024) not confirmed (see Heiss & Péricart 2007)
Aradus (*Aradus*) *reuterianus* Puton, 1875					■				SZ: Heiss & Péricart (2007)
Aradus (*Aradus*) *ribauti* Wagner, 1956	■		■	■	■		■	■	CZ: Kment et al. (2005), SK: Stehlík & Heiss (2001), SZ: Heiss & Péricart (2007)
Aradus (*Aradus*) *serbicus* Horváth, 1888	■						■	■	GE: Morkel (2010)
Aradus (*Aradus*) *signaticornis* R.F. Sahlberg, 1848	■	■	■					■	
Aradus (*Aradus*) *truncatus* Fieber, 1860	■	■	■	■	■		■	■	SZ: Wyniger et al. (2003)
Aradus (*Aradus*) *versicolor* Herrich-Schaeffer, 1835	■	■	■	■	■		■	■	
Quilnus marcosi Heiss & Baena, 2006					■				SZ: Gossner et al. (2018)
Calisiinae Stål, 1873									
Aradosyrtis salicis (Horváth, 1913) (= *Calisius salicis* Horváth, 1913)							■		Heiss (2015, new combination)
Mezirinae Oshanin, 1908 (1843)									
Mezira tremulae tremulae (Germar, 1822)	■	■	■	■			■	■	AU: Eckelt & Heiss (2017), CZ: Kment et al. (2003), Ezer (2019)

OMGM Oblastní muzeum a galerie v Mostě, Most, Czech Republic

PHKC Petr Horsák private collection, Kladno, Czech Republic

PMJ Phyletisches Museum, Jena, Germany

SMOP Slovenské múzeum ochrany prírody a jaskyniarstva, Liptovský Mikuláš, Slovakia

SZPC Šimon Zeman private collection, Praha, Czech Republic

VHNC Václav Hanzlík private collection, Neratovice, Czech Republic

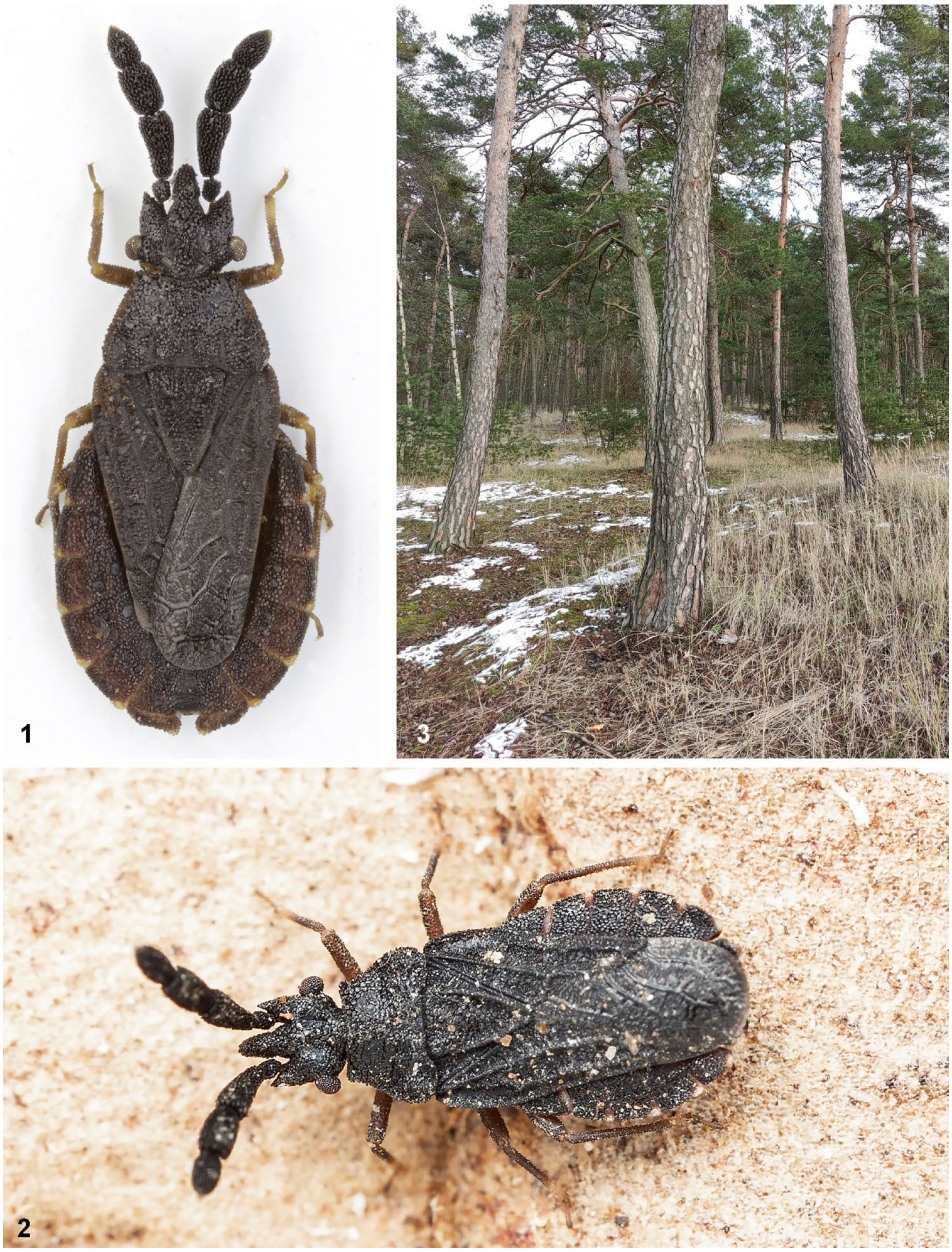
ZJPC Zdeněk Jindra private collection, Praha, Czech Republic

Results and discussion

Aradus mirus Bergroth, 1894 (Figs 1, 2, 7, 8)

Material examined. Austria, Lower Austria: Rekawinkel [near Pressbaum, ca. 48°11′ N, 16°02′ E], undated, 1 ♂ (macropterous), 4 ♀♀ (brachypterous), L. Ganglbauer lgt., H. Zettel det. (NHMW, probably no syntypes); Mödling [ca. 48°04′50.7″ N, 16°16′55.7″ E], 1894, 4 ♂♂ (macropterous), 7 ♀♀ (brachypterous), 15 nymphs, collector unknown, W. Rabitsch det. (NHMW); [Mödling], Husarentempel [48°04′37.11″ N, 16°15′06.30″ E], 29.IV.[no year], 1 ♀ (brachypterous), L. Ganglbauer lgt., H. Zettel det. (NHMW); Hinterbrühl [ca. 48°04′43.6″ N, 16°14′21.2″ E], undated, 1 ♀ (brachypterous), L. Ganglbauer lgt., W. Rabitsch det. (NHMW); Brühl [= Hinterbrühl, ca. 48°04′43.6″ N, 16°14′21.2″ E], [18]94, 12 ♂♂ (macropterous), 10 ♀♀ (brachypterous), 7 nymphs, L. Ganglbauer lgt., W. Rabitsch det. (NHMW); Brühl [= Hinterbrühl, ca. 48°04′43.6″ N, 16°14′21.2″ E], undated, 50 ♂♂, 6 ♀♀ (macropterous), 41 ♀♀ (brachypterous), 23 nymphs, L. Ganglbauer lgt., W. Rabitsch det. (NHMW); Kirchberg am Wechsel [ca. 47°36′44.7″ N, 15°59′18.3″ E], [19]01, 1 ♀ (macropterous), 1 ♀ (brachypterous), L. Ganglbauer lgt., W. Rabitsch det. (NHMW); Altenburg [ca. 48°38′47,20″ N, 15°35′33,66″ E], 28.V.[19]28, 1 ♀ (macropterous), 13.V.[19]30, 1 ♂ (macropterous), coll. Minarz, H. Zettel det. (NHMW); [Heiligenkreuz], Füllenberg [ca. 48°03′56.20″ N, 16°09′00.42″ E], 7.IX.[19]31, 1 ♀ (brachypterous), unknown collector, H. Zettel det. (NHMW); Kaltenberg "near Edlitz" [ca. 47°36′45.8″ N, 16°10′54.0″ E], 1937, 1 ♀ (brachypterous), W. Kühnelt lgt., E. Heiss det. (NHMW); Lichtenegg [ca. 47°35′27.3″ N, 16°12′11.0″ E], [ca. 1930–1940], 1 ♂ (macropterous), 4 ♀♀ (brachypterous), L. Mader lgt., W. Rabitsch det. (NHMW); Schlatten [ca. 48°08′12.8″ N, 15°16′0.2″ E] environment, [ca. 1930–1940], 8 ♂♂ (macropterous), 12 ♀♀ (brachypterous), 8 nymphs, L. Mader lgt., W. Rabitsch det. (NHMW); Bad Vöslau [47°58′10.7″ N, 16°10′39.0″ E], [ca. 1930–1940], 1 ♂ (macropterous), 1 ♀ (brachypterous), G. Paganetti lgt., E. Heiss det. (NHMW); Pressbaum [ca. 48°11′5.1″ N, 16°04′41.1″ E], [ca. 1930–1940], 3 ♀♀ (brachypterous), 8 nymphs, L. Mader lgt., W. Rabitsch det. (MNÖ); Bucklige Welt [ca. 47°37′37.9″ N, 16°10′33.7″ E], 11.V.1941, 2 ♂♂, 1 ♀ (macropterous), Mader lgt., F. Stöcklein det. (NMPC); the same locality, undated, 6 ♂♂ (macropterous), 17 ♀♀ (brachypterous), Mader lgt., E. Heiss det. (NHMW); Purgstall environment, Zehnbach, Steinfeldberg, on bark of *Pinus sylvestris*, 14.VI.1957, 1 ♀ (brachypterous), F, Ressl lgt., H. Zettel det.; Purgstall environment, Sölling, Schlarassingbach [not fully readable], from bundle of twigs of *Pinus sylvestris*, 6.IX.1959 and undated, 3 ♀♀ (brachypterous), F, Ressl lgt., H. Zettel det.; [Hohe] Mandling, south slope, undated, "X1398", 1 ♀ (brachypterous), H. Franz lgt., E. Wagner det. (NHMW). – Vienna: Dornbach [Vienna, 17th District], 31 ♂♂, 13 ♀♀ (macropterous), 65 ♀♀ (brachypterous), 23 nymphs, A. Handlirsch lgt., H. Zettel det. (NHMW).

Czech Republic, Bohemia: Děčín env., Podskalí, Kaňon Labe National Nature Reserve (5151; 50°48′53.8″ N, 14°13′42.0″ E), aluvium of Labe river, 21.IX.2006, 1 ♂, J. Strejček lgt. (LBVC); Schwaden [= Ústí nad Labem – Svádov] (5350; 50°39′36.9″ N, 14°06′31.9″E), 18.VI.1944, 1 ♀ (macropterous), collector unknown, P. Kment det. (NMPC); Kojovice, Košátecký les forest, pine monoculture (5653d; 50°17′59.5″ N, 14°40′9.6″ E; Figs 4, 5), on dead branches of *Pinus sylvestris*, ca. 250 m a.s.l, 3.VII.2016, dozens of adults and larvae, V. Hanzlík lgt. & det.; same locality, pine



Figs 1–3. Habitus and habitat of *Aradus mirus*: (1) submacropterous female from Bor u Skutče, Maštale NR (body length 5.24 mm); (2) living macropterous male from Louny, Podbořany, Vroutek military training area; (3) *Pinus sylvestris* forest in Vroutek military training area. © 1: P. Kment; 2–3: P. Krásenský.

Figs 4–5. Habitat of *Aradus mirus*, Košátecký les pine forest at Kojovice (4), with detail of dry cut-off branches inhabited by numerous adults and larvae of this species (5). © V. Hanzlík.

Figs 6–8. Habitat and living specimens of *Aradus mirus* Bergroth, 1894. (6) pine forest with dry cut-off branches inhabited by numerous adults and larvae at Slaný, Lotouš; (7–8) detail of living adult (7) and larvae (8) on beating sheet, Košátecký les forest at Kojovice. © 6: P. Horsák; 7–8: V. Hanzlík.

monoculture (5653d; 50°17′44.7″ N, 14°39′36.0″ E), on dead branches of *Pinus* ? *nigra*, ca. 245 m a.s.l., 3.VII.2016, dozens of adults and larvae, V. Hanzlík lgt. & det. (22 spec. in VHNC); Slaný, Lotouš (5750c; 50°15′09.9″ N, 14°01′04.5″ E; Fig. 6), 293 m a.s.l., 9.IV.2016, 1 ♀, P. Horsák lgt. & det., P. Kment revid. (PHKC); same locality, 316 m a.s.l., 18.VI.2016, dozens of adults and larvae, P. Horsák observ., lgt. & det. (Fig. 6, PHKC); Milovice, Mladá National Nature Monument, env. of Ruská cesta road (5755; 50°15′18″ N, 14°52′03.3″ E), deciduous forest margin, beaten from *Pyrus communis*, 22.V.2021, 1 spec., V. Hanzlík lgt. & det. (VHNC); Louny, Podbořany, Vroutek military training area (5846; 50°11′54.3″ N, 13°23′31.2″ E; Fig. 3), 385 m a.s.l., 10.I.2021, 1 ♂, under bark at foot of *Pinus sylvestris*, P. Krásenský lgt. & det. (OMGM); Poříčany env., Kersko (5855, 50°09′23.4″ N, 14°55′00.2″ E), on *Pinus* sp., 11.X.2010, 2 ♂♂, 3 ♀♀, 1 L5, L. John lgt., P. Kment det. (NMPC); Týniště nad Orlicí, game park (5862; 50°11′22″ N, 16°04′28″ E), 9.V.1958, 1 ♀ (macropterous), Z. Bouček lgt., Z. Jindra det. (ZJPC); Plzeň, Obora (6146, 49°53′21.1″ N, 13°24′46.1″ E), +276, no date [given as 1976 in error by Kment et al. (2013)], 1 ♀ (macropterous), collector unknown, L. Hoberlandt 1963, det. (NMPC); Vrané, Libřice (6152; 49°53′32.5″ N, 14°24′25.8″ E), 16.VI.1930, Rambousek lgt., L. Hoberlandt, det. (NMPC); Bor u Skutče, Maštale Nature Reserve, Na Tintěrkách (6162; 49°49′11.7″ N, 16°07′23.0″ E), *Pinus sylvestris* forest at margin of peaty meadow, suction sampling, 2.IX.2020, 1 ♀ (submacropterous), I. Malenovský lgt., P. Kment det. (NMPC); Stará Huť u Dobříše (6251, 49°47′40.4″ N, 14°12′15.8″ E), on dry branch of *Pinus sylvestris* laying on the ground, 5.VII.2016, 7 specimens, V. Hanzlík lgt. & det. (VHNC); Chotilsko-Mokrsko env., Vymyšlenská pěšina Nature Monument (6252; 49°44′43.8″ N, 14°21′27.5″ E), dwarf *Quercetum*, sifting, 28.X.1992, 1 ♀ (macropterous), J. Strejček lgt., P. Kment det. (NMPC); Vlkov nad Lužnicí (6854a; 49°09′59.7″ N, 14°42′59.1″ E), Vlkovská pískovna sandpit, pine forest near a flooded sandpit, 413 m a.s.l., sweeping, 22.V.2023, 1 ♂, Š. Zeman lgt. & det. (SZPC).

Germany, Thuringia: Jena, Steinbruch am Mönchsberg (50°52′56″ N, 11°34′58″ E), 8.IV.2024, sieved bark of *Pinus sylvestris*, 304 m a.s.l., 1 ♂ (macropterous), D. Tröger lgt. & det. (PMJ).

Slovakia: Trenčín (7174; 48°53′28″ N, 18°02′32″ E), no date, 1 ♀ (macropterous), Čepelák lgt., P. Kment det. (NMPC); Košice (7293; 48°43′10″ N, 21°15′18″ E), VIII.1933, 1 ♂, 2 ♀♀ (macropterous), L. Hoberlandt lgt. & det. (2 ♀♀ NMPC, 1 ♂ ZJPC); Tomky (7468b; ca. 48°34′27.5″ N, 17°05′29.3″ E), 27.VI.1993, 1 ♀, O. Majzlan lgt., V. Hemala det. (SMOP).

Published records [year of collecting]. Austria, Burgenland: St. Michael bei Güssing [1978] (Adlbauer & Heiss 1980); Rechnitz [1982] (Heiss & Péricart 2007). – Lower Austria: Rekawinkel [<1894; 1930–1940s] (Bergroth 1894a (syntypes), 1894b, Hoberlandt 1944a, Stehlík 1946, this paper); Brühl [= Hinterbrühl; 1894] (Franz & Wagner 1961, this paper); Mödling [<1894] (Bergroth 1894b, this paper); Kamptal [1936] (Rabitsch 2007); Langegg [1951] (Heiss & Péricart 2007); Pressbaum [1930–1940s] (Hoberlandt 1944a, Stehlík 1946, this paper); Wachau [1951] (Rabitsch 2007); Prigglitz [1954] (Heiss & Péricart 2007); Zehnbach [1957] (Ressl & Wagner 1960, Ressl 1983, this paper); Sölling [1959] (Ressl & Wagner 1960, Ressl 1983, 1995); Bucklige Welt [1941] (Hoberlandt 1944a, Stehlík 1946, Franz & Wagner 1961, this paper); Hochrieß [1973] (Ressl 1995); Eichkogel bei Mödling [1994–1995] (Rabitsch et al. 1998). Mandling-Südhang [= Hohe Mandling, 1953, this paper] (Franz & Wagner 1961). – Vienna: Dornbach [1894] (Bergroth 1894b, Sienkiewicz 1964, Vásárhelyi 1985, this paper).

Czech Republic, Bohemia: Libřice u Vraného nad Vltavou [1930 – provided here] (Hoberlandt 1944a,c, 1956); Svádov [1944 – provided here] (Hoberlandt 1956); Sedlice, Želivka reservoir, Sedlické údolí valley [1966] (Kment et al. 2013); Obora u Plzně [not indicated – here corrected] (Kment et al. 2013); Křivoklát, Na Babě Nature Reserve [1988] (Kment et al. 2013); Louňovice pod Blaníkem, Velký Blaník [1988] (Kment et al. 2013); Julčín, Na Černčí Nature Reserve [1999] (Kment et al. 2013); Skláře u Mariánských Lázních [2001] (Kment et al. 2013); Sedlčany env., Kosova Hora [2005] (Kment et al. 2013); Vráž u Písku [2010] (Kment et al. 2013). – Moravia: Mohelno, Mohelnská hadcová step NNR [1941] (Stehlík 1946, Stehlík & Heiss 2000); Kostelní Myslová [1973] (Kment et al. 2013); Nemotice, SE slopes of Vysoká hill [1979] (Stehlík & Heiss 2000); Bzenec – Přívoz [2010] (Kment et al. 2013).

Germany, Thuringia: Bodensberg, north of Gumperda / Röttelmisch [2021] (Küssner 2021).

Hungary: Sopron [1943] (Vásárhelyi 1975).

Poland, Upper Silesia: Szczedrzyk [2018] (Gierlasiński & Regner 2018).

Slovakia: Košice [1933] (Hoberlandt 1944b, c, Stehlík & Heiss 2001); Trenčín [< 1944] (Hoberlandt 1944b, c, Stehlík & Heiss 2001); Malacky (Kment et al. 2013).

Bionomy. *Aradus mirus* is associated with two native species of Central European pines – Scots Pine, *Pinus sylvestris* (data from the Czech Republic, Germany, Poland, Austria and Slovakia – Bergroth 1894b, Ressl & Wagner 1960, Ressl 1983, Heiss & Péricart 2007, Rabitsch 2007, Wachmann et al. 2007, Gierlasiński & Regner 2018, Küssner 2021) and Austrian Pine, *P. nigra* (native populations of the tree in Austria – Bergroth 1894b, Heiss & Péricart 2007, Rabitsch 2007, Wachmann et al. 2007; non-native population in Bohemia – this paper).

Adults were found under the detached bark of pine stumps (Wachmann et al. 2007) or trunks (Ressl & Wagner 1960, Ressl 1983, Gierlasiński & Regner 2018 [dead trunk]), or were beaten from branches (Bergroth 1894b [dry branches], Hoberlandt (1944a, c) and Franz & Wagner (1961) [dead branches], Wachmann et al. (2007) [not specified], Kment et al. (2013) [not specified], Küssner (2021) [lower branches, otherwise not specified]). Ressl & Wagner (1960) and Ressl (1983) reported to have beaten this species from bundles of pine brushwood consisting of fresh, still coniferous twigs. Hoberlandt (1944c) found several specimens on the bark of young pines.

Most of these records are based on findings of single or very few adults leading to a biased view of the species bionomy. In search of the true microhabitat of *A. mirus*, the findings of multiple adults are of great importance. These records point to dry, still coniferous branches or twigs of pines (Bergroth 1894b, Ressl 1983). In this paper, we can confirm these observations. At Stará Huť, seven adults were beaten from broken-off dry branches of *Pinus sylvestris* (V. Hanzlík, pers. observ.). At Kojovice (Figs 4, 5), *A. mirus* was found in two localities in a pine monoculture with cut-off small trees and trimmed branches, at one location still scattered throughout the forest and piled up in the second location; most of the needles were already almost or completely dry. Dozens of adults and hundreds of larvae were beaten from these branches (V. Hanzlík, pers. observ.; Figs 7, 8). Finally, at Slaný (Fig. 6), this species was collected in a pine forest on sandy soil at the edge of a forest path where there were dry, still needle-bearing pine branches lying on the ground for a long time. After tapping these branches, both the larvae and adults fell into an umbrella in quite large numbers from each branch (P. Horsák, pers. observ.).

Hoberlandt (1944a, c) and Franz & Wagner (1961) also mention the occasional but rare findings on dead branches of White Fir (*Abies concolor*). Ressl (1995) sifted one specimen from leaf litter under barberry (*Berberis*) next to a solitary Scots Pine. In Hungary, this species was collected on a clearing near Sopron (Vásárhelyi 1975). We report here a finding of an isolated adult sifted in late October in dwarf oak forest Vymyšlenská pěšina Nature Monument and another one beaten in May from a pear tree (*Pyrus communis*) at a deciduous forest margin. Such findings may represent overwintering sites or accidental findings of migrating specimens.

Different authors mention that this species sucks sap from the phloem of living trees, similar to *Aradus cinnamomeus* (Ressl & Wagner 1960, Franz & Wagner 1961, Rabitsch 2007, Heiss & Péricart 2007). Wachmann et al. (2007), however, doubt these reports, noting that it is uncertain whether *A. mirus* sucks sap on living parts of trees or mushroom

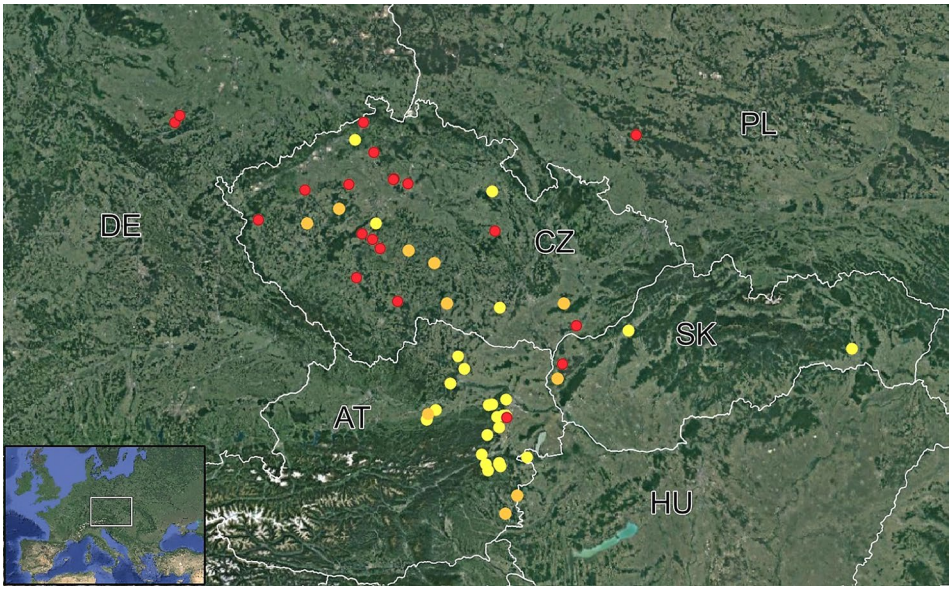


Fig. 9. Distribution map of *Aradus mirus* Bergroth, 1894. Yellow points – known distribution between 1894–1959; orange points – known distribution between 1960–1989; red points – known distribution after 1990.

hyphae on dead parts. The findings of adults and larvae on dry(ing) branches of pines rather support the second hypothesis. The claim of predatory nutrition (Hoberlandt 1944c) is clearly a mistake.

Males are always macropterous, and females occur in macropterous, submacropterous or brachypterous form (Heiss & Péricart 2007, Wachmann et al. 2007). The larvae of the fourth and fifth instars were described by Vásárhelyi (1985). The development of this species is acyclic, both adults and larvae overwinter (Hoberlandt 1944a, c, Wachmann et al. 2007, Rabitsch 2007, Heiss & Péricart 2007). We can report numerous larvae of the species from June and July.

H a b i t a t . This species was collected in different habitats: in relict pine forests on steep serpentinite slopes (Mohelnská hadcová step steppe) (Stehlík 1946, Stehlík & Heiss 2000), *Pulsatillo-Pinetea* (Julčín, Na Černčí) (Kment et al. 2013), aeolian sands afforested by Scotch Pine (Bzenec-Přívoz) (Kment et al. 2013), mixed forest with Scotch Pine (Zehnbach: Steinfeldberg) (Ressl 1983), light stands of Scotch Pine on xerothermic southern slope of a hill (Röttelmisch: Bodensberg) (Küssner 2021), secondary Scotch Pine forest near a flooded sandpit (Vlkov nad Lužnicí), as well as cultivated pine monocultures (Slaný, Kojovice) (this paper).

According to previous authors, it is a thermophilous species living in lowlands (Wachmann et al. 2007, Rabitsch 2007, Heiss & Péricart 2007). However, the present records from Bohemia, with localities in the environs of Sedlčany, Mariánské Lázně and Budislav, are situated in medium warm areas, as well as in Upper Silesia. It seems this species avoids the central parts of Central European mountain systems (Alps, Carpathians, Sudetes, Bohemian-Moravian Highlands). Its records concentrate along margins of the mountain

ranges or in deeply cut river valleys, e.g. on sandstone or serpentinite rocks, with xerothermic localities on their south-oriented slopes. These localities are often covered with relict pine forests or pine plantations in areas where relict pine stands once existed (e.g. on aeolian sands). However, at Jena-Steinbruch in Germany, *A. mirus* was found in a stand of *Pinus sylvestris* and *P. nigra* artificially planted after closing the quarry in a region where pines do not occur naturally (D. Tröger, pers. comm.).

Conservation. In Lower Austria (Rabitsch 2007) as well as in the Czech Republic (Kment et al. 2017), the species is classified as endangered, in Austria as vulnerable (Rabitsch & Friess 2024), and in Slovakia (Hemala in press) even as critically endangered. The discovery of the microhabitat inhabited by this species now allows targeted sampling and will help to re-evaluate its status and distribution in the future.

Distribution (Fig. 9, Tab. 2). Rabitsch (2009) considered the species as subendemic to Austria, i.e. more than 75% of the total distribution range being located in Austria; based on the data presented here, this statement has to be dismissed. However, *Aradus mirus* has to be considered as an endemic species to Central Europe.

Tab. 2. Known distribution of *Aradus mirus* Bergroth, 1894. Abbreviations: AU – Austria (AU: B – Burgenland, AU: N – Lower Austria, AU: W – Vienna), CZ – Czech Republic (CZ: B – Bohemia, CZ: M – Moravia), GE – Germany, HU – Hungary, PL – Poland, SK – Slovakia.

Country	Locality	Collecting year	Coordinates °N, °E
AU: B	Sankt Michael im Burgenland	1978	47.127474, 16.269151
AU: B	Rechnitz	1982	47.303395, 16.439931
AU: N	Rekawinkel [near Pressbaum]	< 1894	48.180302, 16.028185
AU: N	Mödling	< 1894	48.080757, 16.282133
AU: N	Hinterbrühl	1894	48.0787778, 16.2392222
AU: N	Kirchberg am Wechsel	1901	47.6124167, 15.9884167
AU: N	Bad Vöslau	1930–1940	47.9696389, 16.1775000
AU: N	Lichtenegg	1930–1940	47.5909167, 16.2030556
AU: N	Pressbaum	1930–1940	48.1847500, 16.0780833
AU: N	Schlatten	1930–1940	48.1368889, 15.2667222
AU: N	Kamptal [region]	1936	48.525991, 15.682106
AU: N	Kaltenberg [near Lichtenegg]	1937	47.6127222, 16.1816667
AU: N	Bucklige Welt [region]	1941	47.627184, 16.176031
AU: N	Langegg [near Aspangberg-St. Peter]	1951	47.547411, 16.020988
AU: N	Wachau [region]	1951	48.389713, 15.474718
AU: N	Hohe Mandling [mountain, near Waldegg]	1953	47.8915711, 16.0087261
AU: N	Prigglitz	1954	47.704950, 15.927668
AU: N	Zehnbach [near Purgstall an der Erlauf]	1957	48.043684, 15.142024
AU: N	Sölling [near Purgstall an der Erlauf]	1959	48.040589, 15.139896
AU: N	Hochrieß [near Purgstall an der Erlauf]	1973	48.091000, 15.157777
AU: N	Eichkogel [hill, near Mödling]	1994–1995	48.0625, 16.2925
AU: W	Dornbach [17th District]	1894	48.231008, 16.280867
CZ: B	Libřice near Vrané nad Vltavou	1930	49.8923561, 14.4071672
CZ: B	Svádov	1944	50.6602447, 14.1088528

Country	Locality	Collecting year	Coordinates °N, °E
CZ: B	Týniště nad Orlicí, game park	1958	50.1895733, 16.0743994
CZ: B	Sedlice, Želivka reservoir, Sedlické údolí valley	1966	49.5233847, 15.2478661
CZ: B	Obora u Plzně	?	49.8892086, 13.4128033
CZ: B	Louňovice, Velký Blaník	1988	49.6415589, 14.8728947
CZ: B	Křivoklát, Na Babě NR	1988	50.0255650, 13.8809867
CZ: B	Chotilsko env., Vymyšlenská pěšina NM	1992	49.7454992, 14.3576314
CZ: B	Julčín, Na Černčí NR	1999	50.5477428, 14.3744403
CZ: B	Skláře near Mariánské Lázně	2001	49.9273806, 12.7175778
CZ: B	Sedlčany env., Kosova Hora	2005	49.6565586, 14.4717964
CZ: B	Děčín env., Podskalí	2006	50.8149536, 14.2283350
CZ: B	Vráž near Písek	2010	49.3838050, 14.1272217
CZ: B	Kersko	2010	50.1564925, 14.9167333
CZ: B	Slaný, Lotouš	2016	50.2527533, 14.0179064
CZ: B	Kojovice	2016	50.2998594, 14.6693278
CZ: B	Kojovice	2016	50.2957500, 14.6600000
CZ: B	Stará Huť u Dobříše	2016	49.7945556, 14.2043889
CZ: B	Bor u Skutče, Maštale NR	2020	49.8199167, 16.1230556
CZ: B	Louny, Podbořany, Vroutek MTA	2021	50.1984275, 13.3920014
CZ: B	Milovice, Mladá NNM	2021	50.2550000, 14.8675833
CZ: B	Veselí nad Lužnicí, Vlkovská pískovna sandpit	2023	49.1665833, 14.7164167
CZ: M	Mohelno	1941, 1975	49.106889, 16.188187
CZ: M	Kostelní Myslová	1973	49.1481708, 15.4290103
CZ: M	Nemotice	1979	49.1426853, 17.1093286
CZ: M	Bzenec – Přívoz	2010	48.9380681, 17.2919661
GE	Röttelmisch, Bodensberg	2021	50.8187056, 11.5190306
GE	Jena, Steinbach am Mönchsberg	2024	50.8822222, 11.5827778
HU	Sopron	1943	47.681018, 16.581834
PL	Szczedryk	2018	50.702458, 18.153280
SK	Košice	1933	48.719532, 21.254979
SK	Trenčín	< 1944	48.891013, 18.042297
SK	Malacky	1987	48.434728, 17.022654
SK	Tomky	1993	48.5742089, 17.0914622

Relationships. *Aradus mirus* seems to be isolated within the genus *Aradus*, together with the species *A. reuterianus* Puton, 1875, forming a separate *A. mirus* species group. *Aradus reuterianus* occurs on pines (*P. sylvestris*, *P. nigra*, *P. canariensis*, *P. halepensis*) in the Mediterranean: Canary Islands, Morocco, Algeria, Portugal, Spain, southern France (including Corse), Switzerland (Valais), northern Italy (Aosta, Alto Adige), Croatia (Senj), Greece (Peloponnesos, Achaia, Lesbos), and western Turkey (Alanya env.) (Ramade 1960, Ribes 1984, Moulet 1986, Heiss & Péricart 2007, Baena & Zuzarte 2012, Parmain et al. 2013, Kment & Carapezza 2022). Elucidating the phylogenetic position of these two species will require obtaining DNA samples and including them in a genus-wide analysis.

Summary

1) *Aradus mirus* is trophically bound to native Central European species of pines, *Pinus sylvestris* and *P. nigra*, and develops on dry(ing) broken-off branches lying on the ground.

2) It inhabits various localities in warm (thermophyticum) or medium warm (mesophyticum) regions usually with relict occurrence or long historical continuity of pine populations.

3) It is the only flat bug species endemic to Central Europe, limited to north-east Austria, Slovakia, the Czech Republic, and a single historical locality in Hungary. Only recently, it was found in Germany (Thuringia) and southern Poland (Upper Silesia). It should be mentioned that *Pinus sylvestris* does not occur naturally in Hungary and in the southern areas of Slovakia (EUFORGEN 2008).

4) In Austria, Slovakia and Moravia, respectively, there is only a single recent finding of this species recorded in the past 30 years. On the other hand, during this period, the species was rather frequently collected in Bohemia and newly discovered in Thuringia and Upper Silesia. It is a question of whether such a pattern is merely an artefact of insufficient sampling or whether the species distribution range is moving north under global warming conditions.

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