First records of *Aedes pulcritarsis* (Rondani, 1872) (Diptera: Culicidae) in Austria

Karin Bakran-Lebl¹,² · Hans Jerrentrup³ · Eleni Daroglou³ · Wolf Peter Pfitzner⁴ · Hans-Peter Fuehrer² · Franz Allerberger¹

Received: 13 July 2021 / Accepted: 5 January 2022 © The Author(s) 2022

**Abstract**

*Aedes pulcritarsis* is a tree-hole breeding species with its main distribution in the Mediterranean area. Within the scope of two independent monitoring programmes, this mosquito species was detected for the first time in Austria, in the province of Lower Austria (2018, districts Mistelbach and Gaenserndorf; 2020, district Bruck an der Leitha). As the climatic and habitat situation in Central Europe seems to be generally suitable for this species, the most likely explanation for the species not being recorded previously is that it might have been overlooked in the past due to its specialized breeding habitat. However, further research on the distribution of *Ae. pulcritarsis* in Austria would be needed to support this hypothesis. The results from this study will contribute to the investigation of the northern distribution limit of *Ae. pulcritarsis* in Europe and possible changes thereof.

**Keywords** *Aedes pulcritarsis* · Austria · Mosquitoes · Species inventory

**Introduction**

*Aedes* (*Ochlerotatus*) *pulcritarsis* (Rondani, 1872) (in some literature incorrectly spelled *Ae. pulchritarsis*) is a species of the Western Palaearctic, with its main distribution in the Mediterranean region. It has been documented in the following countries/regions: Albania, Algeria, Azerbaijan, Bulgaria, Croatia, Czech Republic, France (incl. Corsica), Georgia, Greece, Hungary, Israel, Italy (incl. Sicily), Kosovo, Lebanon, Moldova, Montenegro, Morocco, Portugal, Romania, Russia (south-western incl. Crimean Peninsula), Serbia, Slovakia, Spain (incl. Balearic Islands), Tunisia and Turkey (Robert et al. 2019) and Iran (Azari-Hamidian 2007). Additionally, in 2016, a single specimen was reported from a rural area near a fragmented forest in the federal state of Rhineland-Palatinate in Germany (Kampen et al. 2017).

*Aedes pulcritarsis* uses phytotelms, especially tree-holes, as its preferred breeding sites. A study conducted in Israel found *Ae. pulcritarsis* breeding in tree-holes of oaks (*Quercus calliprinos*, *Q. boissieri*, *Q. ithaburensis*), planes (*Platanus palestinensis*, *P. orientalis*) and eucalyptus (*Eucalyptus* sp.). Breeding sites were only found in shady areas of woodlands with mature trees, located in forested mountainous areas with high annual precipitation (Müller et al. 2012). The temperature of the water in the breeding sites never exceeds 21 °C and larval development may take 2 months (Becker et al. 2020).

*Aedes pulcritarsis* usually has two generations per year (Becker et al. 2020). In contrast to many other mosquito species preferring small water hollows as breeding sites, such as *Ae. albopictus*, *Ae. japonicus* or *An. plumbeus*, there are no records of this species breeding in tyres, road drains or rock pools. Although they generally seem to avoid man-made habitats, larvae have been observed in wooden buckets (European Centre for Disease Prevention and Control 2012; Müller et al. 2012).
Here, we report the first findings of *Ae. pulcritarsis* in Austria.

**Material and methods**

Individuals of *Ae. pulcritarsis* were captured within the scope of two independently conducted mosquito monitoring programmes (Fig. 1; created using program R (R Core Team 2021)). Both programmes were conducted within the same province, Lower Austria, but represent quite different habitats.

**Mosquito monitoring A**

Mosquito monitoring A is conducted in the most eastern part of Austria in the floodplains of the transboundary rivers March/Morava and Thaya/Dyje (March-Thaya-Ramsar Wetlands; within the districts Mistelbach and Gaenserndorf).

Mosquito monitoring B is conducted at the Vienna International Airport (48.111°N, 16.569°E, 183 m a.s.l.) to detect the possible introduction of alien mosquito species via air travel. The airport is located near the city of Vienna, in the district of Bruck an der Leitha. The airport is located at the north-western edge of the Pannonian biogeographic region, which is characterized by a humid continental climate. Since 2018, sampling has been taking place in a green courtyard, approximately 70 m from the airport’s movement area. In this courtyard, a BG-Sentinel 2 (Biogents AG, Regensburg, Germany), equipped with a CO₂ release and a specific lure (BG-Sweetscent), is set up from the beginning of May to the end of October. The trap is operated continuously, and captured mosquitoes are collected weekly (Bakran-Lebl et al., 2021a).

**Mosquito identification**

Female mosquitoes were identified to species level by morphological characteristics using the keys of Gunay et al. (2018) and Becker et al. (2020). The morphological characteristics of *Ae. pulcritarsis* are very similar to *Ae. berlandi*, as females differ only slightly in the scutal colouration pattern (Becker et al. 2020). Thus, additional identification by DNA barcoding was conducted. For this, DNA was extracted from one leg of each individual. To this end, three 1.4-mm ceramic beads (Precellys Ceramic Kit 2.8 mm, Peqlab, Erlangen, Germany) were added to each tissue sample. Homogenization was performed with a TissueLyser II (Qiagen, Hilden, Germany). Afterwards, DNA was extracted using a blood and tissue DNA isolation kit (DNeasy®, Qiagen, Hilden, Germany) according to the manufacturer’s instructions. Conventional polymerase chain reactions (PCRs), targeting the barcode region within the mitochondrial cytochrome c oxidase subunit I gene (COI), using primers H15CuliCOIFw and
The most likely explanation for this recent recovery of Ae. pulcritarsis in Austria is that this species has been overlooked in the past, since Ae. pulcritarsis uses tree-holes as breeding habitats, and these sites are not well investigated in most parts of Austria. The climatic and habitat situation in Central Europe seems to be generally suitable for Ae. pulcritarsis, because this species was described in the recent past for all neighbouring countries of Austria except Switzerland (Kampen et al. 2017; Robert et al. 2019). Since Ae. pulcritarsis has not been found earlier despite the long-standing mosquito monitoring programme in this area (mosquito monitoring A), this species is probably very rare in Lower Austria.

Although its main distribution is in the Mediterranean area, Ae. pulcritarsis can be found in many countries in Central Europe. The northern border of the distribution area of this species is marked by countries located in the same latitude or even further north than Austria, e.g. France, the Czech Republic or Slovakia (Robert et al. 2019). However, in those northern fringe areas, Ae. pulcritarsis is expected to occur at much lower abundances than in its main distribution area. To our knowledge, there are no reports showing or indicating that Ae. pulcritarsis has, due to recent environmental or climatic changes, dispersed farther north from its known distribution area. However, due to the lack of detailed information on this species’ distribution in Europe, the possibility of active spread of Ae. pulcritarsis from neighbouring countries because of changing climatic and environmental conditions cannot be ruled out. An introduction via human-made containers (such as tyres) also seems very unlikely, as Ae. pulcritarsis does not usually use these as breeding habitats.

To our knowledge, Ae. pulcritarsis has never been associated with dispersal via road or air transport. Although one specimen was found at the Vienna airport, the occurrence at the second location makes an introduction via air travel unlikely. However, more detailed studies on the distribution of Ae. pulcritarsis are needed to confirm our assumption that this species is indeed native to Austria.

Aedes pulcritarsis is anthropophilic and presumably also zoophilic, and it is known to feed during daytime (Nikookar et al. 2010; Becker et al. 2020). However, this species seems to be rare in Austria, and its distribution is likely limited by its specialized breeding sites in woodlands with mature trees, located in forested mountainous areas with high annual precipitation (Müller et al. 2012). This reduces contact with people and thus its role as a nuisance species to humans. Currently, there is no information available on its vector status.

In combination with data from other European countries, the results presented here will contribute to the investigation of the northern distribution limit of Ae. pulcritarsis and Ae. koreicus, which have also been reported for Austria (Seidel et al. 2012; Fuehrer et al. 2020; Bakran-Lebl et al., 2021b).
possible changes to it. These first findings of a new mosquito species for Austria also suggest that the culicid fauna in Austria is still insufficiently documented and that further mosquito species, especially such with specialized and little studied breeding sites such as tree-holes, remain to be discovered.

Acknowledgements KBL and FA would like to thank the staff of the Vienna International Airport for their support and help with the mosquito monitoring (especially the team of the fire brigade and medical service). We are grateful to Bita Shahi Barogh and Christina Czajka for their contribution to the molecular analyses.

Funding Open access funding provided by University of Veterinary Medicine Vienna.

Declarations

Conflict of interest The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

Azari-Hamidian S (2007) Checklist of Iranian mosquitoes (Diptera: Culicidae). J Vector Ecol 32(2):235–242. https://doi.org/10.3376/1081-1710(2007)32[235:COIMDC]2.0.CO;2
Bakran-Lebl K, Camp JV, Kolodziejek J, Weidinger P, Hufnagl P, Cabal Rosel A, Zwickelstorfer A, Allerberger F, Nowotny N (2021a) Diversity of West Nile and Usuto virus strains in mosquitoes at an international airport in Austria. Transbound Emerg Dis. https://doi.org/10.1111/tbed.14198
Bakran-Lebl K, Zittra C, Harl J, Shahi-Barogh B, Grätzl A, Ebner D, Schaffner F, Fuehrer H-P (2021b) Arrival of the Asian tiger mosquito, Aedes albopictus (Skuse, 1895) in Vienna, Austria and initial monitoring activities. Transbound Emerg Dis 68(6):3145–3150. https://doi.org/10.1111/tbed.14169
Becker N, Petrić D, Zgomba M (2020) Mosquitoes - identification, ecology and control, 3rd edn. Springer, Cham, Switzerland, p 570
European Centre for Disease Prevention and Control (2012) Guidelines for the surveillance of invasive mosquitoes in Europe. Technical Report. ECDC, Stockholm, p 72
Folmer O, Black M, Hoeh W, Lutz R, Vrijenhoek R (1994) DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Mol Mar Biol Biotechnol 3(5):294–299
Fuehrer HP, Schoener E, Weiler S, Barogh BS, Zittra C, Walder G (2020) Monitoring of alien mosquitoes in Western Austria (Tyrol, Austria, 2018). PLoS Negl Trop Dis 14(6):e0008433. https://doi.org/10.1371/journal.pntd.0008433
Gunay F, Picard M, Robert V (2018) MosKeyTool, an interactive identification key for mosquitoes of Euro-Mediterranean. Version 2.1. In English available at www.medlabsecure.com/moskeytool. Last update: 01.08.2018.
Kampen H, Schulbauer A, Walther D (2017) Emerging mosquito species in Germany - a synopsis after 6 years of mosquito monitoring (2011–2016). Parasitol Res 116(12):3253–3263. https://doi.org/10.1007/s00436-017-5619-3
Lebl K, Nischler EM, Walter M, Brugger K, Rüb1 F (2013) First record of the disease vector Anopheles hyrcanus in Austria. J Am Mosq Control Assoc 29(1):59–60. https://doi.org/10.2987/12-6282.1
Lebl K, Zittra C, Obwaller A, Berer D, Brugger K, Walter M, Pinior B, Fuehrer H-P, Rüb1 F (2015) Mosquitoes (Diptera: Culicidae) and their relevance as disease vectors in the city of Vienna. Austria Parasitol Res 114(2):707–713. https://doi.org/10.1007/s00436-014-4237-6
Müller GC, Kravchenko VD, Junnila A, Schlein Y (2012) Tree-hole breeding mosquitoes in Israel. J Vector Ecol 37(1):102–109. https://doi.org/10.1111/j.1948-7134.2012.00206.x
Nikookar S, Moosa-Kazemi S, Oshaghi M, Yaghoobi-Ershadi M, Vatandoost H, Kianinasab A (2010) Species composition and diversity of mosquitoes in Neka County, Mazandaran Province, northern Iran. Iran J Arthropod Borne Dis 4(2):26–34
R Core Team 2021. R: A Language and Environment for Statistical Computing. Version 4.0.5. Vienna, Austria, R Foundation for Statistical Computing
Robert V, Gunay F, Le Goff G, Bousses P, Sulesco T, Khalin A, Medlock JM, Kampen H, Petrić D, Schaffner F (2019) Distribution chart for Euro-Mediterranean mosquitoes (Western Palaearctic region). J Europ Mosq Control Assoc 37:1–28
Seidel B, Duh D, Nowotny N, Allerberger F (2012) Erstnachweis der Stechmücken Aedes (Ochlerotatus) japonicus japonicus (Theobald, 1901) in Österreich und Slowenien in 2011 und für Aedes (Stegomyia) albopictus (Skuse, 1895) in Österreich 2012 (Diptera : Culicidae). Entomol Z 122:223–226
Seidel B, Nowotny N, Duh D, Indra A, Hufnagl P, Allerberger F (2013) First records of the thermophilic mosquito Culiseta longiareolata (Macquart, 1838) in Austria, 2012, and in Slovenia, 2013. J Eur Mosq Control Assoc 29(1):59–60. https://doi.org/10.1111/j.1948-7134.2012.00206.x
Vatandoost H, Kianinasab A (2010) Species composition and diversity of mosquitoes in Neka County, Mazandaran Province, northern Iran. Iran J Arthropod Borne Dis 4(2):26–34
Werblow A, Flech E, Klimpel S, Zittra C, Lebl K, Kieser K, Laciny A, Silbermayr K, Melaun C, Fuehrer H-P (2016) Direct PCR of indigenous and invasive mosquito species: a time- and cost-effective technique of mosquito barcoding. Med Vet Entomol 30(1):8–13. https://doi.org/10.1111/mve.12154
Zittra C, Obwaller AG, Wimmer V, Berer D, Eigner B, Fuehrer H-P (2017) First record of Orthopodomyia pulciropalpis (Rondani, 1872) (Diptera: Culicidae) in Austria. Parasitol Res 116(6):1781–1783. https://doi.org/10.1007/s00436-017-5460-8

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.