

SCIENTIFIC NOTE

Aedes albopictus IN-HOUSE WINTER BREEDING IN GERMANY—A CASE STUDY

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ABSTRACT. In February 2024, a resident of Mannheim, Germany, collected aggressively attacking mosquitoes in her home and forwarded them to the “Mueckenatlas” citizen science recording scheme. The specimens turned out to be *Aedes albopictus*. Upon discussing the situation and consultation on the biology of the Asian tiger mosquito, the submitter found numerous developmental stages in the water of a flowerpot with an orchid in her living room. The occurrence of adult tiger mosquitoes during wintertime in Central Europe has never been described before and is probably just an indoor phenomenon. Ideal conditions provided and continued indoor breeding and activity might be an exceptional way for the species to overwinter.

KEY WORDS Asian tiger mosquito, indoor development, overwintering

Because it is a pest and an efficient vector of numerous pathogens, the Asian tiger mosquito *Aedes albopictus* (Skuse) is a major health problem in its distribution areas (Paupy et al. 2009, Bonizzoni et al. 2013). Being very adaptable, it is one of the most invasive species in the world (Lowe et al. 2000), and it is emerging in more and more countries (Medlock et al. 2015, Kraemer et al. 2019). As of October 2023, it was established in at least 23 European countries (<https://www.ecdc.europa.eu/en/publications-data/aedes-albopictus-current-known-distribution-october-2023>), including Germany, where it had first been detected in 2008 (Pluskota et al. 2008). Populations are now widely distributed along the Upper Rhine Valley in the southwestern federal state of Baden-Württemberg, the warmest area in Germany and the closest to the invasion areas in southern Europe. Additional populations exist in Bavaria, Hesse, Thuringia, and Berlin (<https://www.flii.de/de/kommissionen/nationale-expertenkommission-stechmuecken-als-uebertraeger-von-krankheitsserregern>). Detections from 2023 in other German federal states have still to be confirmed.

Aedes albopictus is a poor flyer, actively covering distances of only a few hundred meters (Hawley et al. 1988). Instead of actively migrating, dispersal is mediated by human activities. Eggs and larvae of the species are both inter- and intracontinentally displaced by the trade in used tires, ornamental plants, and machinery (Scholte and Schaffner 2007, Swan et al. 2022). Since females are aggressive biters and follow people into cars, they can also be transported over considerable distances on the ground by vehicle traffic (Eritja et al. 2017). Apparently, traffic from southern Europe is the main mode of *Ae. albopictus* introduction into Germany (Becker et al. 2013, Kampen et al. 2013).

As a thermophilic species, *Ae. albopictus* is not well adapted to the Central European climate. Notwithstanding, it finds its ecological niches and can survive the winters via its eggs (Pluskota et al. 2016, Walther et al. 2017). In diapausing strains, these are quite cold-resistant, enduring low temperatures over extended periods of time and even freezing temperature spells of a few days (Tippelt et al. 2019, 2020). However, substantial numbers of eggs are also thought to overwinter in protected places, such as catch basins and drainage systems, where temperatures are moderate in winter (Ravasi et al. 2018). According to records of the “Mueckenatlas” citizen science scheme, which has been collecting mosquito occurrence data for Germany since 2012 (Walther and Kampen 2017), seasonal activity of adult *Ae. albopictus* in Germany ends in late October or early November.

On February 17, 2024, a citizen from Mannheim (northern Baden-Württemberg) contacted the “Mueckenatlas” team about the recent emergence of mosquitoes in her home looking and behaving like *Ae. albopictus*. Unfortunately, she had killed and discarded the mosquitoes. However, the contacting person had already submitted a tiger mosquito from her place in September 2023 and, in turn, received an identification result and information on its biology, suggesting that she had an idea of what a tiger mosquito looked like. Two days later, February 19, she found another mosquito in her house, caught it, and sent it to the “Mueckenatlas.” Upon identification of that specimen as *Ae. albopictus*, one of the authors contacted her by phone to get more information on her living conditions and the circumstances of the mosquito encounter. The citizen reported additional specimens of the same appearance and behavior having bothered her during the previous days in her house. She was informed that mosquito outdoor development is nearly impossible during wintertime (December to February) in Germany and that adult mosquito activity in winter has so far been described only for native species hibernating as females. It was suggested that she check small water containers such as

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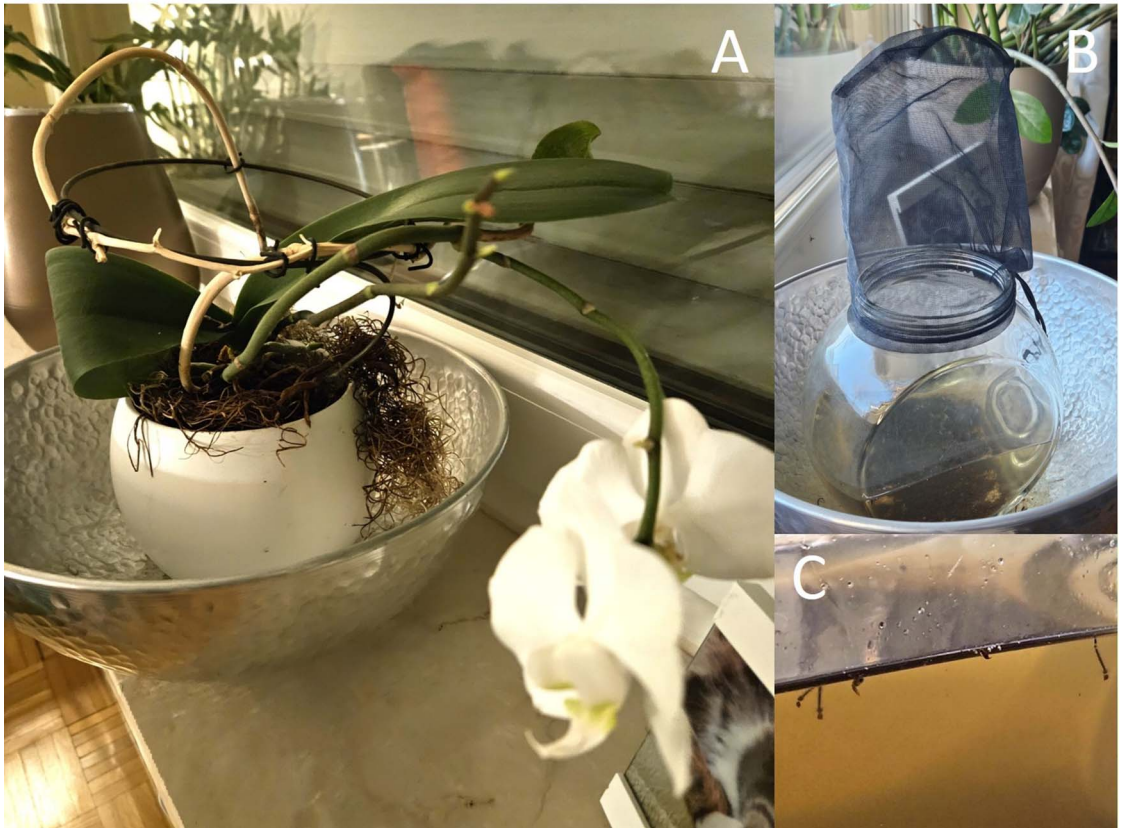


Fig. 1. (A) *Phalaenopsis* sp., (B) water removed from orchid pot, (C) *Ae. albopictus* larvae and pupae recovered.

flower vases and, if present, water drains in her house for “small wiggling worms.”

Within a few days, the submitting citizen reported the probable identification of the mosquito source. In her living room, she identified an orchid (*Phalaenopsis* sp.) flowerpot with stagnant water from which mosquito larvae and pupae could be recovered (Fig. 1A). As instructed, she poured the water containing the mosquito stages into a small glass container that she covered with a net (Figs. 1B, 1C). Every 2 days, she replaced the net and put the one containing the freshly emerged mosquito adults into the freezer overnight. The next day, the dead mosquitoes were transferred into a small plastic container that was left open for humidity to evaporate. After 2 wk, all aquatic stages had developed into adults, and the plastic container with the emerged adults, together with 2 additional tiger mosquitoes collected while flying around in the room, was sent to the “Mueckenatlas” team.

Altogether, the mosquito collection in Mannheim produced 16 specimens of *Ae. albopictus* from February 17 onwards, 10 of which developed from the immature stages in the orchid water and were captured by the net placed above. It was concluded that the specimens present after the orchid water had been secured had emerged already before since the

search for additional sources was unsuccessful. The temperature in the living room, where the orchid was kept, was a constant 21°C.

Activity of adult *Ae. albopictus* appears to be limited to temperatures above 13°C (Osório et al. 2020). Despite climate warming, these temperatures are rarely reached in German winters, particularly not in February. According to the records of the Mannheim weather station of the German Weather Service, the average February 2024 temperature was 8.7°C (https://www.dwd.de/DE/leistungen/pbfb_verlag_monat_klimastatus/monat_klimastatus.html). In fact, *Ae. albopictus* adults submitted to the “Mueckenatlas” have never been collected before mid-May in areas known to be colonized by the species, and never before mid-July in areas without known populations, the latter most likely representing specimens freshly introduced from southern Europe (unpublished data).

Irrespective of the season and outdoor temperatures, *Ae. albopictus* specimens obviously developed under appropriate conditions indoors in the present case. Hardly any descriptions exist on adult winter activity of thermophilic mosquito species in temperate geographic areas. Although presenting no details and, in part, even contradictory information, Dutoo and Mosca (2017) report on the regular presence of *Ae. albopictus*

immature stages and adults from December to March 2009 to 2016 in buildings in Turin, northern Italy, where the long-term average outdoor temperature is 2.1°C in January. Another case of indoor winter development of an exotic mosquito species, *Ae. aegypti* (L.), in a moderate climate was also described from Germany (Kampen et al. 2016). The yellow fever mosquito went through its complete life cycle in a building at about 25°C room temperature in March. In contrast to *Ae. aegypti*, which is not established in Germany and had most likely been introduced as eggs into the household from abroad (Kampen et al. 2016), *Ae. albopictus* is present in Germany with numerous populations. In 2023 a new population was detected in the municipality of Mannheim, but still about 10 km away from the site of the described indoor winter activity. Further populations occur in other surrounding cities, such as Ludwigshafen and Heidelberg (both at least 12 km away).

Although the person affected in this case study had collected a tiger mosquito already in late September 2023, a population has so far not been identified close to her house. It is therefore neither clear where the female producing the indoor mosquito generation came from nor when it deposited its eggs in the orchid flowerpot. The flower itself had already been in the household for almost 2 years, suggesting that the eggs were not introduced with it.

Should the mother female have belonged to a native strain, eggs and larvae must be assumed to undergo diapause. Since diapause is triggered not only by temperature but also by photoperiod (Pumpini et al. 1992), diapause should have taken effect in an established and adapted strain in late autumn because of the reduced day length, so development would have come to a standstill in the German winter. A hatching of larvae in early February would therefore seem unlikely. Therefore, a more likely option is the fresh introduction of a female not conditioned to produce diapausing eggs, i.e., from a subtropical or tropical area, followed by oviposition, either in late autumn 2023 or during wintertime. Nondiapausing eggs attached to the flowerpot or the orchid itself could have been triggered to larval hatching while excessively watering the flower. Since orchids are usually not kept in stagnant water, larvae might have not hatched sooner. Although precise circumstances remain obscure, *Ae. albopictus* indoor development in winter and possibly overwintering by continuous indoor development seems possible.

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