

## Adult *Aedes albopictus* in winter: implications for mosquito surveillance in southern Europe



*Aedes albopictus*, commonly referred to as the Asian tiger mosquito, is an invasive species that was introduced into Europe in the late 20th century. *Ae albopictus* has since spread and has been recorded in more than 25 European countries.<sup>1-3</sup> To date, the European Centre for Disease Prevention and Control categorises *Ae albopictus* as established in 13 of these countries, with prominence in the Mediterranean region.<sup>3</sup> The species' potential as a vector for more than 20 arboviruses, including dengue, chikungunya, and Zika, has raised substantial public health concerns.<sup>4</sup> The expanding distribution of *Ae albopictus* represents a notable risk to public health.

Furthermore, the climate suitability for vector borne diseases is escalating rapidly in Europe.<sup>5</sup> Climate change is contributing to the expansion of *Ae albopictus*' habitat suitability, allowing it to proliferate at higher altitudes and latitudes.<sup>6</sup> These changing climate conditions heighten the need for immediate action to tackle this public health threat. To enable informed decision making for public health interventions, it is crucial to be able to accurately assess the risk of transmission.<sup>7</sup> Surveillance and control activities play an essential role in both preventing and managing outbreaks.

For instance, in the region of Attica, encompassing Greece's capital, Athens, the presence of *Ae albopictus* was first detected in 2008.<sup>2</sup> This discovery led to the establishment of an oviposition surveillance network, which revealed the widespread distribution of *Ae albopictus* within Athens, where it is the dominant container-breeding *Aedes* species.<sup>2,8</sup> Results from previous surveillance periods showed that *Ae albopictus* oviposit in Attica from May until early December, with a peak during the summer months and comparatively small numbers of adults detected in December. Diapause eggs had been detected in winter months beyond December, but these remained dormant and did not hatch; adult *Ae albopictus* had not been detected in the winter months beyond December in Attica.<sup>7,9</sup>

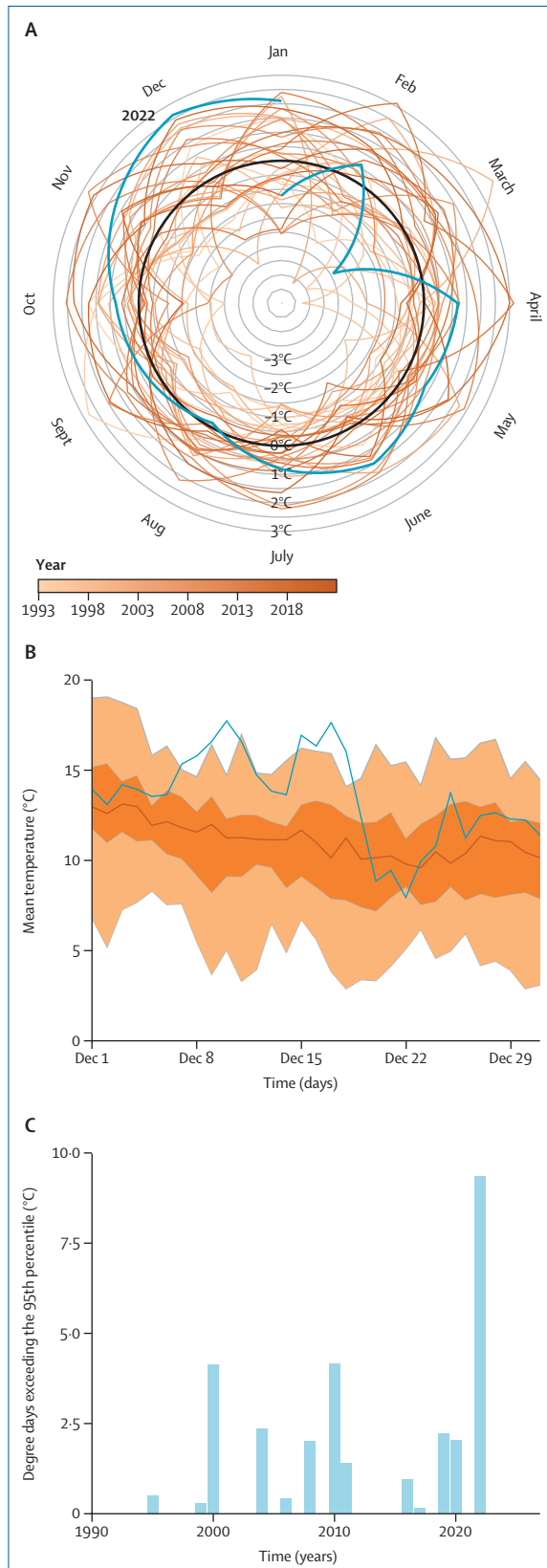
During the 2022–23 winter season, adult *Ae albopictus* were active until the end of January 2023 for the first time and were captured in large numbers (99 individuals in 55 Biogents sentinel traps deployed). The population recorded was high in December 2022, compared with

previous years (714 in December 2022 vs 150 adults in December 2021, and far fewer in any previous December).

To understand how winter temperatures in 2022 might have played a role in this unusual phenomenon, we analysed monthly temperature anomalies (difference from the long-term average) between January 1993 and January 2023, using weather station data provided by the Hellenic National Meteorological Service. As an illustrative case, we examined weather data from Elefsina, a town situated in the northwestern coastal area of Athens. Specifically, we focused on temperatures for the month of December, 2022. An evident upward trend is observed, with December being recorded as the warmest December to date (figure A). During several days, the mean daily temperature in December exceeded the 97.5th percentile of the historic records (figure B). December 2022 showed a record breaking number of degree days exceeding the 97.5th percentile compared with previous years (figure C).

Attica is not the only region in southern Europe to have recorded adult *Ae albopictus* activity during the winter, although other detections have been smaller and more sporadic. For example, adult *Ae albopictus* have been detected in Barcelona by the Agència de Salut Pública de Barcelona (ASPB) several times in December and January, as far back as 2016, but these detections sum to a total of only 22 individuals over a 7 year period, and many of them have been in locations that would have offered shelter from cold temperatures (eg, greenhouses or outdoor huts). Moreover, detection has resulted from entomological surveillance rather than complaints from the public, suggesting that winter *Ae albopictus* presence remains uncommon and is not yet considered a nuisance. In addition to restricted detections by public health agencies like ASPB, citizen scientists have sporadically reported *Ae albopictus* with the Mosquito Alert platform during December and January in Albania, Italy, and Spain as far back as 2015. However, these reports sum up to a total of only 21 individuals reported in those months during the entire period for Albania, Italy, and Spain combined.

For the Mosquito Alert platform see <http://www.mosquitoalert.com/>



**Figure: Temperature data in Attica, Greece, from the Elefsina weather station in Attica, Greece**

Figures are based on the daily mean temperatures made available by the Hellenic National Meteorological Service. (A) Anomalies of monthly mean temperatures, from January 1993 to January 2023, relative to the reference period from 1993 to 2021 (black circle). Lighter colours represent earlier years, whereas darker colours represent more recent years. Monthly mean anomalies for January to December 2022 and January 2023 are shown in blue. (B) Comparison of the daily mean temperature in December 2022 (blue curve), with the median value over the 1993–2021 reference period (red curve), the IQR (dark orange shading), and the central 95 percent of the distribution (2.5th to 97.5th percentile; light orange shading). (C) Sum of the degree days by which the daily 97.5th percentile of the reference period (1993–2021) temperature value was exceeded each day for the month of December between 1993 and 2022.

Catalonia and other areas of southern Europe displayed similar temperature patterns in December 2022, compared with Attica, raising the question of why more adult *Ae albopictus* were not detected there. Whatever the reason, these sporadic observations, particularly when combined with the observations this year in Attica, suggest the importance of extending the *Ae albopictus* surveillance period in southern Europe. With climate change making warmer winters a reality in the future, the presence of adult vector mosquito activity might become the norm. These recent findings show the need for continued surveillance efforts, especially during winter, to monitor the behaviour of *Ae albopictus* as it adapts to climate change. Additionally, an appropriate management plan should be implemented that considers the resources necessary to mitigate the potential health consequences associated with the extended seasonal life cycle of this invasive mosquito species.<sup>1</sup>

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