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Aedes albopictus arrives in Lisbon: an emerging public health threat

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Introduction

The recent identification in Lisbon, Portugal, of the invasive mosquito species *Aedes albopictus (Ae. albopictus)*, also known as the Asian tiger mosquito, was recently reported by the Public Health authorities (1). This raised significant concerns among the local scientific community, even though viruses were not identified within these mosquitoes. Originating from Southeast Asia, the species is a major vector for several arboviruses, including dengue, Zika, chikungunya, and yellow fever (2), and its increasing presence in areas beyond the classic geographical range underscores concern regarding the potential global expansion of mosquito-borne diseases.

For some decades, *Aedes* species' distribution was thought to be restricted to equatorial, subequatorial, and tropical zones (corresponding to the sub-Saharan Africa, Southeast Asia, and part of the South and Central America). However, in recent years, these mosquitoes have been able to occupy areas above and below these isotherms eventually also reaching temperate zones (which include Europe and North America, but also South America e.g., Argentina and Chile).

The invasive journey of *Aedes spp* into Europe and North America

Aedes albopictus has been on a global invasive journey toward Europe and North America since the 1980s. First reported in Albania in 1979, and later in Texas (USA) in 1985, it established populations in several European countries and spread to more than 32 states in the USA (3, 4). In recent years it was implicated in short-term outbreaks of chikungunya and dengue in Italy, France, Florida, Texas, and Arizona (5, 6).

Aedes albopictus eggs can stand extended periods of desiccation resisting even in extreme conditions through diapausing mechanisms. Facilitated by human activities, *Ae. albopictus* eggs are capable of dispersing over considerable distances in short periods of time, facilitating the spread into new territories, provided there are favorable ecosystems for survival and reproduction. Like any other mosquito, *Ae. albopictus* requires water bodies to lay eggs that will hatch into larvae and develop to pupae before emerging as adult mosquitoes. *Ae. albopictus*' ability to breed in small amounts of water, and its evolutive preference by artificial water containers, commonly found in urban areas, facilitates the proliferation of the mosquito populations and its rapid expansion in densely populated regions. Usually, these water containers that act as breeding

sites are part of dwellings turning the local human community into a critical stakeholder in vector control strategies.

In addition to its ecological plasticity, *Ae. albopictus* benefits from human economical activities such as the frequent exchange of goods and travelers, facilitated by globalization and further supported by climate change (2, 3). Moreover, if the mosquito population establishes in a new region, and survives throughout the winter season, eradication becomes very challenging (7).

Historical records suggest the presence of an *Aedes* species in North America and Europe prior to World War II, which may have been eradicated during the eradication of malaria *Anopheles* vectors through Dichlorodiphenyltrichloroethane (DDT) applications, a widely used insecticide in vector control campaigns (8, 9). Currently DDT is not used due to well-known risks for human health and the environment, as well mosquito populations showing high levels of resistance to DDT and other common insecticides (10).

Stringent surveillance and sustainable control of *Ae. albopictus* needs to be implemented by Public Health authorities to stop the introduction of associated mosquito-borne viruses, but so far no consensus exists on how this can be achieved.

Aedes aegypti, a mosquito species closely related to *Ae. albopictus*, is also expanding its range, particularly in North America. While it demonstrates less ecological plasticity, *Ae. aegypti* is often considered a more efficient vector for viral transmission, being a primary vector of several arboviruses, including dengue, Zika, chikungunya, and yellow fever. In 2005, *Ae. aegypti* was identified on Island of Madeira, Portugal. Subsequently, in 2012, the island faced the first dengue outbreak with +2,000 human confirmed cases (11). During the last two decades, Portugal's mainland escaped the importation of this species but *Ae. albopictus is now regularly observed*, most likely introduced from neighboring Mediterranean countries. Its presence in Portugal was first detected in 2017, with populations recorded in the North of the country, and the Algarve and Alentejo districts (South) (1, 12). Its recent identification in September 2023 in Lisbon, is a warning for the urgent need for stringent surveillance and Public Health control interventions. Portugal can benefit of the expertise and knowledge acquired through prior work done in Madeira and develop a strategy based on tailored communication initiatives, to promote effective community-based prevention (13).

Discussion

The continuous invasion of *Ae. albopictus* represents an increasing threat of yellow fever, dengue, Zika, and chikungunya, to immunologically naïve populations, with the risk of expansion at a global scale (14). The changing distribution of this vector highlights the need for heightened awareness and action in both the Global North and the Global South, which is crucial for a unified global response against infectious diseases. Addressing these public health challenges particularly by improving surveillance, establishing efficient control measures, and preparedness for the development of new vaccines against known pathogens in immunological naïve populations, particularly against Zika and chikungunya due to the absence of licensed vaccines. The recent success of mRNA vaccines created a wide interest for the rapid development of vaccines against virtually every infectious disease, and Zika and chikungunya mRNA vaccine candidates are currently in Phase I clinical trials (15).

Climatic change is playing an important role, facilitating the establishment of vectors and viruses beyond their classic tropical and subtropical geographical boundaries, by favoring e.g., environmental conditions for mosquito reproduction. While this presents a challenge into the future, it also provides opportunities for research, surveillance and control. Natural climate variation is such a determinant factor to mosquito life cycles (16–18), that it is a powerfully informative input to emerging mathematical modeling techniques capable of projecting the dynamics and spatial distributions of both mosquitoes and viruses (19). The contribution of this field of research into the future is ever more relevant, since it can pinpoint spatial-temporal details for optimized surveillance and control, which are needed to effectively stop the establishment of *Aedes spp* into new territories.

Although *Ae. albopictus* has been identified in several regions of Portugal, it is the first time to be identified in Lisbon. The latter is the largest urban center in the country and a hub of international travel including frequent movement to/from South America and Southeast Asia where arboviruses of public health concern are endemic. This serves as a pressing reminder and a call to action for the scientific community, Public Health authorities and civil society, emphasizing the emerging threat posed by invasive mosquito species and the diseases they amplify. Collaborative and proactive efforts, including extensive Public Engagement are essential to implement effective control measures, raise awareness, and protect communities from the spread of this invasive vector. The time to act is now, investing in communication, surveillance and research, toward preventing the establishment and proliferation of *Ae. albopictus* in new national territories, to protect our communities from eventual forthcoming disease outbreaks.

Author contributions

TN: Conceptualization, Writing—original draft, Writing—review & editing. GS: Writing—original draft, Writing—review & editing. JL: Writing—original draft, Writing—review & editing. PB: Conceptualization, Writing—original draft, Writing—review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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