Zootaxa 4413 (1): 197–200
http://www.mapress.com/j/zt/

Correspondence

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4413.1.10
http://zoobank.org/urn:lsid:zoobank.org:pub:9438C154-8869-45C9-8D1C-596FD632C04A

The Asian tiger mosquito, *Aedes* (*Stegomyia*) *albopictus* (Skuse), a vector of dengue, chikungunya and zika viruses, reaches Portugal (Diptera: Culicidae)

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The Asian tiger mosquito, *Aedes* (*Stegomyia*) *albopictus* (Skuse), is a tropical species originally from south-eastern Asia (Hawley, 1988). It has experienced a rampant human-mediated range expansion since the 1970s to now occupy almost the whole of the tropical and subtropical areas of the world. As an eclectic haematophagous species, it attacks humans and is able to use a number of man-made and natural structures where stagnant water is present (Estrada-Franco & Craig, 1995). Eggs are able to survive for extended periods of time in complete dryness and diapause over unsuitable cold season, making it an especially resilient species (Hawley, 1988).

The worldwide spread of *Ae. albopictus* began with the Pacific and Indian islands, followed by North America in 1985, Brazil and other South American nations in subsequent years. Africa was colonised in 2000, despite isolated records since at least 1990 (Benedict *et al*., 2007). The closely related *Ae. aegypti* (Linnaeus) is a long-known species in Europe, reported in mainland Portugal until the 1950s, and is now established on the island of Madeira, where it has been responsible for heightened public-health issues (Almeida *et al*., 2007; Sousa *et al*., 2012). *Aedes albopictus* only reached Europe in 1979, arriving in Albania, presumably as eggs or larvae in used water-filled tyres (Adhami & Reiter, 1998). It has now expanded through the peri-Mediterranean area (Kraemer *et al*., 2015), east to Georgia (Kutateladze *et al*., 2016) and west to the rest of southern Europe.

After fully colonising Italy and the Mediterranean coast of France, the earliest report from the Iberian Peninsula is from 2004, when the species was found in Catalonia (Aranda *et al*., 2006). Here, the spread of the species progressed particularly fast along the warmer Mediterranean shoreline. The most recent colonies of *Ae. albopictus* to be reported were found in 2015 near Algeciras in central Andalucía Province (Collantes *et al*., 2016) and in Gibraltar in August 2017, following a report issued by proMED. This is about 240 km from the Portuguese border along the Atlantic coast. The presence of the mosquito itself had long been anticipated in Portugal (Benedict *et al*., 2007), informed by the national news during 2016, but the mosquito had eluded all the intensive surveying efforts by both Spanish scientists working along the Huelva coast (Collantes *et al*., 2016) and the Portuguese REVIVE (National Network for Vector Surveillance) team working throughout the country (Alves *et al*., 2016).

At the end of July 2017, a population of *Ae. albopictus* was located in the south of Portugal (Algarve) following a seven-day survey carried out in a private condominium near the golf resort of Vila Sol, Vilamoura, Faro, Algarve (coordinates: 37.090, -08.093) (Fig. 1). This location is at least 240 km west of the nearest known population in Spain, near Algeciras.

The site is an anthropogenically engineered subtropical garden with a prevalence of allochthonous flora surrounded by villas, including several swimming-pools. At dusk, several garden lights at ground level are regularly lit and during the night an automatic irrigation system maintains high humidity levels, even during the summer. These favourable conditions, lacking local ecological elements such as predators, favour the presence of alien species, such as the African mantis *Miomantis paykullii* Stål, which was recently discovered at the site (Marabuto, 2014). Not uncommonly, artificial structures are filled with water for long periods of time. For example, the golf-course nearby has several permanent artificial fresh-water bodies, such as ponds, fountains and irrigation ditches.

The first observation of the species corresponds to several females biting humans in the late afternoon of 31 July 2017. From 31 July to 6 August, 58 *Ae. albopictus* males and females were observed or collected with a tube, either biting humans (Fig. 2) or resting among vegetation. One female was seen ovipositing at the margin of a nearby swimming pool.

Accepted by R. Harbach: 5 Dec. 2018; published: 20 Apr. 2018

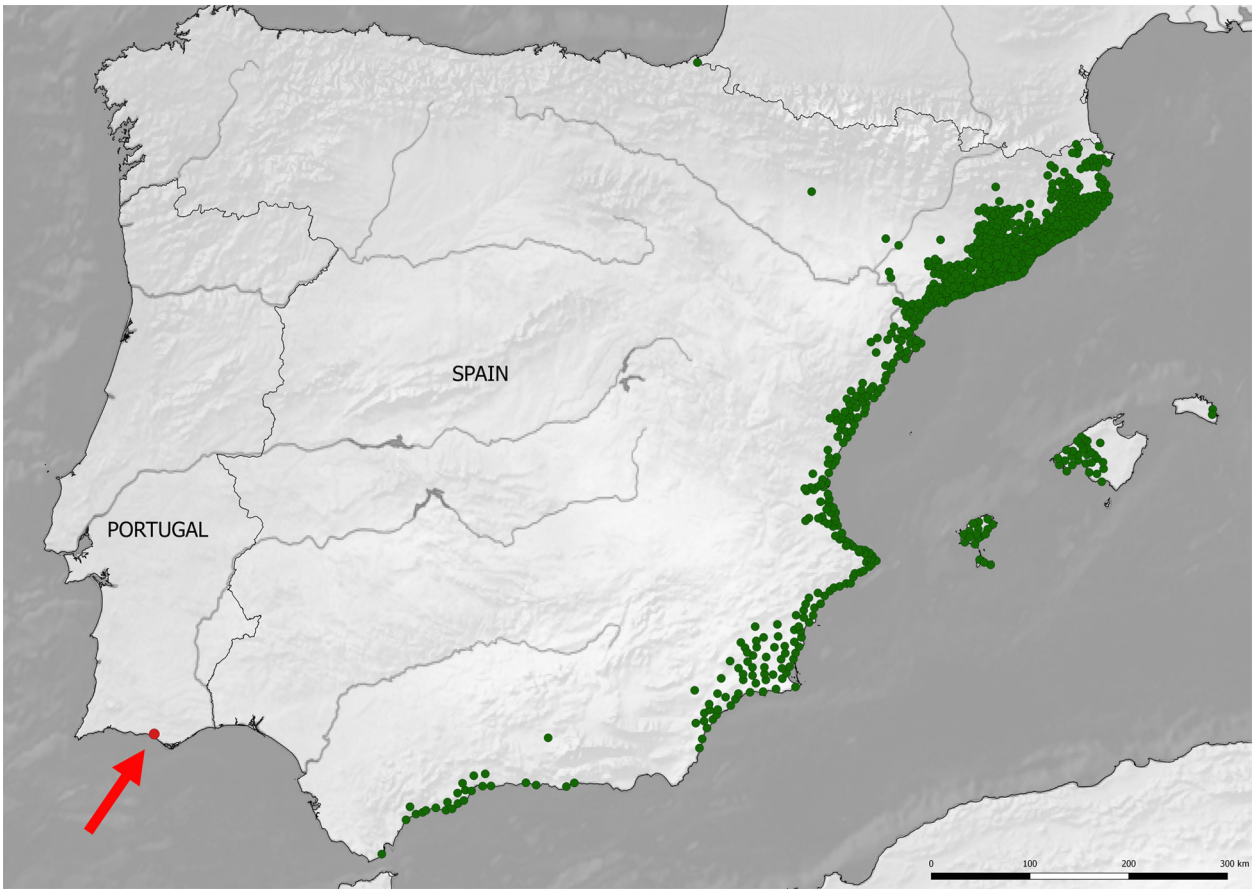

FIGURE 1. Distribution of *Aedes albopictus* in the Iberian Península. In green, distribution in Spain according to Collantes *et al*. (2016). In red, highlighted by arrow, new occurrence in Portugal.

FIGURE 2. Portuguese *Aedes albopictus* females seeking human blood. Note characteristic scutal white stripe, distinct silvery-white scales on the maxillary palpi and tarsi, as well as narrow scales over the wing root and silvery-white basolateral abdominal tergal markings.

Females *in situ* revealed an aggressive behaviour towards humans, as observed by Halasa *et al.* (2014). Specimens arriving and settling to feed on humans at the same place, a villa balcony, for three hours between 18:30 and 21:30 over

three days revealed a peak of activity around 20:30. Activity almost ceased just before complete darkness (21:30), revealing a high population density (Fig. 3). A sample of 25 males and females was collected to confirm species identification. All specimens have a dark proboscis and tibiae and the scutum sports a prominent silvery-white stripe. Distal submedian white parallel lines to the prominent white line are very short to absent, distinguishing this species from the poorly known but otherwise similar *Ae. cretinus* (Edwards). Moreover, all specimens show an absence of a white spot on the midfemur. All of these characters correspond perfectly with *Ae. albopictus*.

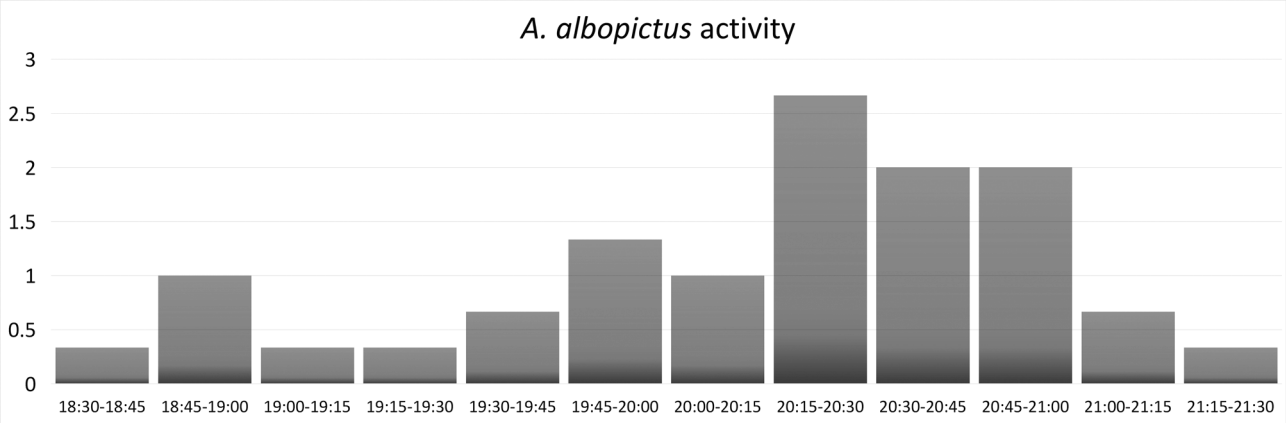

FIGURE 3. Biting activity of *Ae. albopictus* assessed by human-bait catches. Specimens arriving to bite were captured every 15 minutes to avoid recapture. The x axis is a timeline of 15-minute intervals; the y axis is an average of the three days of sampling.

Aedes albopictus is an ecologically aggressive and plastic species, evidently able to cope with and benefit from human changes to natural ecosystems (Medlock *et al*., 2012). In Europe, since 1979, the species has progressively colonised suitable, usually anthropogenic habitats, from Georgia to the Iberian Peninsula.

With its presence confirmed in Portugal, this mosquito has reached the Atlantic shores, one of the most suitable areas for the species (Kraemer *et al*., 2015; Fischer *et al*., 2014). This suitability is further enhanced by the proliferation of man-made subtropical-type gardens and predator-free water bodies, available year-round.

The ecological and social disturbance caused by this species would not be very different from the many other species currently arriving and establishing themselves within the Mediterranean area, often with ecological impact, and it would pass relatively unnoticed if *Ae. albopictus* was not a well-known vector of several arboviruses. In fact, throughout the tropical areas of the world, and occasionally outside these regions, following travel of infected hosts, this species is able to transmit more than 20 arboviruses, among which are the dengue, yellow fever, chikungunya and zika viruses (Gratz, 2004; Paupy *et al*., 2009; Wong *et al*., 2013).

Outbreaks of these diseases have already taken place in the newly invaded ranges of *Ae. albopictus* and *Ae. aegypti*, with these species involved as vectors. Major events, such as the dengue outbreak in Madeira (Sousa *et al*., 2012) and chikungunya in Italy (Liumbruno *et al*., 2008), must be taken into account as they are now possible in mainland Portugal. Despite intense monitoring, this expanding vector and knowledge of the viruses it may transmit, the reported increasing risk of autochthonous transmission of dengue, chikungunya and zika viruses by Spanish health authorities (CCAES, 2016), is very real to Portugal as well.

Strategies for the prevention and control of this medically important, aggressive invader, emphasising Integrated Vector Management as a multi-sectorial approach, should reinforce linkages between health and environmental studies, providing stakeholders with a complete tool for improving decision making. Combined assessment of potential sites of introduction and local climatic zones may provide evidence for planning efficient control strategies against *Ae. albopictus*.

Acknowledgements

We would like to thank all family members of the first author involved with finding of the mosquito and discussing aspects related to its occurrence, location and apprehension during the time-frame of the study, especially Manuel Marabuto for allowing females to be photographed while feeding. Finally, the authors are grateful to two anonymous referees and the editor who greatly enhanced the manuscript. The research was supported by a FCT (Fundação para a Ciência e Tecnologia), Portugal doctoral grant SFRH/BD/102801/2014 to the first author.

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