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First observations of homodynamic populations of *Aedes albopictus* (Skuse) in Southwest Europe

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Aedes albopictus (Skuse, 1894) (Diptera: Culicidae), commonly known as Asian tiger mosquito, is a native and invasive species from tropical and subtropical areas of Southeast Asia that has colonized temperate regions of America, Africa and Europe in recent decades. Although, it usually breeds in small water bodies like treeholes, it must be noted that *Ae. albopictus* also shows high ecological plasticity and the ability to colonize man-made containers in urban and peri-urban territories. The accidental introduction of eggs and larvae in new countries and continents associated to the transportation of goods such as used tyres or ornamental plants have been deeply studied and documented[1-2]. This highly anthropophilic mosquito has been recently linked with different episodes of local transmission of arboviruses of major public health significance in Mediterranean Europe like dengue and chikungunya. Specifically, huge outbreak of chikungunya occurred in Italy in 2007[3] and some isolated cases of autochthonous dengue fever in southern France and Croatia were also reported in 2010 and 2013[4-6].

The Asian tiger mosquito was first detected in Spain in 2004[7]. The fact that this first reporting site was situated in the Metropolitan area of Barcelona has allowed a quick spread of the species, mainly associated to accidental transport of adults inside vehicles. Barely seven years after, >200 municipalities of Catalonia (northeastern Spain) were colonized by *Ae. albopictus*. Soon, the spread of the species also reached to southern Mediterranean territories of the country, being reported from the provinces of Castellón, Valencia, Alicante, Murcia, Málaga and even Balearic Islands[8-13].

Ae. albopictus was firstly detected in the Mazarrón City of Spain in August 2012, which was supposed to be the most meridional report of the species in Europe till that moment[14]. This area shows excellent thermal conditions for the activity and development of *Ae. albopictus*, with temperatures higher than 25°C (>180 days/yr); annual average temperature stays above 19°C and average temperature never dropped below 10–11°C for even the coldest month of the year (January)[15]. Moreover, frozen eventual periods are practically non-existent. Since, some researchers have reported that progression of tiger mosquito's cycle ceases at critical temperatures <11°C[16], this study area appeared very interesting to investigate the behaviour of the species during winter months. Despite pluviometric conditions of this hot and dry region (200–300 mm of annual rainfall) are far from the suitable scenarios for Asian tiger mosquito establishment (>500 mm of annual rainfall)[17], we can not forget that *Ae. albopictus* is an opportunistic species characterized by its great ability to colonize human-made containers that are flooded by anthropic reasons and not by pluviometric conditions. This is one of the most important explanations to answer why current distribution of *Ae. albopictus* can not be correlated with most predictive models that are actually published in scientific literature. Of course, rainfall is a highlighted factor but not incapacitating in urban and peri-urban environments.

The species has been able to establish itself in Europe due to the laying of drought-resistant eggs that can also resist average temperatures above 0°C during winter months. Although, overwintering of eggs is most prevalent mechanism for winter survival, it should be mentioned that sporadic observations of overwintering adult females have been reported in Italy[18]. The aim of this study was to analyze the activity of *Ae. albopictus* populations during the winter season. The study was carried out in the city of Mazarrón (37° 33' 53"N/1°18' 32"W), Murcia Province, southeastern Spain during December 2012, January and February 2013.

To investigate the likely winter adult survival and larval activity in this warm area, three BG-sentinel traps baited with BG-Lure and three plastic containers filled with water were installed and sampled fortnightly in three peri-urban points where the presence of *Ae. albopictus*

was confirmed during previous months (Table 1). The adult traps were placed at <50 m from containers at each sampling point. Containers were installed in permanent sunny places and sampling on those biotopes was done directly by pipetting the larval stages. The presence of eggs in the internal sides of the container was recorded if any, but eggs were not collected because natural hatching was one the objectives to evaluate. Environmental and water temperatures were measured in each sampling.

Preliminary results indicate that certain percentage of *Ae. albopictus* population showed homodynamic behavior characterized by a slowdown of life-cycle development, but not a strict diapause. In fact, most probably situation currently is a cooccurrence of homodynamic (non-diapausing) and heterodynamic (diapausing) populations of tiger mosquito in Mazarrón, since most of eggs observed during samplings did not hatched during winter; consequently and undoubtedly indicating the eggs at overwintering stage of the species. In any case, the multiplicity of different development stages (eggs, larvae, males and females) clearly reveal that mosquito cycle is active during winter months. Theoretically, this does not appear surprising, as mean temperatures of 10–11°C and a photoperiod with around 11 h of daylight are supposed to be two crucial decisive factors for the hatching of overwintering eggs and both are accomplished in the study area, even during winter months[19]. Moreover, an outdoor biting activity of *Ae. albopictus* females has also been observed occasionally by some attempts of bites to humans during samplings. However, no citizen's complaints were communicated to Local Health Services during these winter months.

In conclusion, though more investigations are needed to dip into the knowledge of overwintering patterns of *Ae. albopictus* in Southern Europe, the preliminary data provided in this study suggest that tiger mosquito is a

Table 1. Information on *Ae. albopictus* collections during winter months (December 2012 to February 2013) in Mazarrón (Murcia, southeast Spain)

Sampling points	1 December	2 December	1 January	2 January	1 February	2 February
Bolnuevo-BG 37° 34' 1.5" N/ 1° 18' 32" W A: 33 m	11 F / 2 M ET: 16.1°C	14 F / 0 M ET°: 15.8°C	3 F / 0 M ET: 14.7°C	2 F / 0 M ET: 14.6°C	1 F / 1 M ET° 14.9°C	4 F / 1 M ET: 15.1°C
Bolnuevo-C 37° 34' 1.1" N/ 1° 18' 31.1" W A: 32 m	L+ (all stages) and E+ WT: 12.2°C	L+(all stages) and E+ WT: 11.9°C	L+ (L3–L4) and E+ WT°: 10.8°C	L- and E- WT: 9.2°C	L- and E- WT: 9.5°C	L+ (L1–L2) and E+ WT: 10.5°C
Los Lorentes-BG 37° 35" 41" N/ 1° 15' 25.3" W A: 90 m	7 F / 1 M ET: 14.9°C	8 F / 2 M ET: 14.5°C	2 F / 0 M ET: 13.6°C	0 F / 0 M ET: 13.9°C	0 F / 0 M ET: 14.1°C	1 F / 0 M ET: 14.1°C
Los Lorentes-C 37° 35' 40" N/ 1° 15' 25.1" W A: 93 m	L+ (all stages) and E+ WT: 11.1°C	L+ (L3–L4) and E+ WT: 10.6°C	L- and E- WT: 8.2°C	L- and E- WT: 8.1°C	L- and E- WT: 8.9°C	L- and E- WT: 9.6°C
Puerto Mazarrón (Balsicas)-BG 37° 33' 41.5" N/ 1° 16' 14.7" W A: 2 m	12 F / 0 M ET: 15.9°C	4 F / 1 M ET: 15.9°C	0 F / 0 M ET: 14.8°C	0 F / 0 M ET: 14.9°C	0 F / 0 M ET: 15°C	1 F / 1 M ET: 15.3°C
Puerto Mazarrón (Balsicas)-C 37° 33' 41.1" N/ 1° 16' 14.5" W A: 2 m	L+ (all stages) and E+ WT: 11.9°C	L+ (L3–L4) and E+ WT: 11.5°C	L- and E- WT: 11°C	L- and E- WT: 10.5°C	L+ (L1–L2) and E+ WT: 10.8°C	L+ (L1–L2) and E+ WT: 11°C

BG—Sentinel trap; C—Container; A—Altitude; F—Females; M—Males; WT—Water temperature (°C); ET—Environmental temperature; Presence of larvae (L+); Absence of larvae (L-); Presence of eggs (E+); Absence of eggs (E-); L1–L2 (Larval stages).

species with surprisingly high physiological and ecological plasticity. These first reports of continuous life-cycle development all over the year, requires us to implement an intensive surveillance in order to analyze likely changes in conventional patterns described regarding the behavior of the species. The information will be very valuable not only to provide a better organization of control campaigns for tiger mosquito, but also to elaborate more reliable predictive models of transmission and elimination of mosquito borne diseases in Southern Europe.

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