



Recent Expansion of *Aedes albopictus* and Factors Influencing its Beginning Invasion in North Africa: A Review

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Abstract: *Aedes (Stegomyia) aegypti* and *Aedes (Stegomyia) albopictus* (Skuse) are known or potential vectors to humans of several arboviruses. Albania was the first European country colonized by *Ae. albopictus* in 1979 which was dispersed after in the majority of European countries including the countries closest to the Maghreb. In Algeria, the identification of *Ae. albopictus* was carried out in 2010, 2014 and 2015. In Morocco, the detection of this mosquito in three breeding sites in the same province of Rabat in 2015 indicates the establishment of *Ae. albopictus* in the country. This new species will rapidly invade the other countries of northern Africa given the important aerial and maritime links with Southern Europe. The reinforcement of border surveillance is necessary to prevent onward transmission among the local population especially with the vectorial competence of this dangerous vector and the increase of imported arboviruses.

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1. Introduction:

Originally from Southeast Asia and Indian Ocean (Medlock et al., 2015; Wilkerson et al., 2015), the "tiger mosquito" has spread throughout the world since the late 1970s. In the tropics, *Aedes (Stegomyia) albopictus* colonizes a whole group of plants retaining rainwater such as cut bamboo stems or coconut shells. International trade in used tires and vegetable decorations, called "lucky bamboo" (Medlock et al., 2015), is the origin of its global dispersion (Simon et al., 2008). Tires are traded internationally for retreading and reuse. However, a tire exposed to the weather and not protected by an appropriate packaging receives the rainwater that persists in it. This creates an ideal oviposition for these mosquitoes. The eggs of *Ae. Albopictus*, resistant to cold and drought and laid on the inside of a tire, can be spread throughout the world and hatched thousands of kilometers from their nesting site. *Ae. albopictus* occurs in the Americas, Africa and Oceania. From a point of arrival, it is then accidentally transported inside a car. Its distribution then mainly follows the road networks.

The adult of *Ae. Albopictus* is recognizable by an alternation of white and dark spots on the body, which gives the species the nickname of "tiger mosquito". The females bite the day, preferentially at the beginning of the morning and at the end of the afternoon, more rarely at night, both inside and outside the houses. They do not have host specificity and may bite humans, mammals, birds, amphibians or reptiles, depending on their

availability (Niebylski et al., 1994) An adult's flight is usually 50 to 70 meters (Estrada-Franco & Craig, 1995), but can extend to over 800 m (Bellini et al., 2010). During the day, adults rest in low vegetation. The female lays its eggs in all kinds of containers (vases, saucer, tires ...) on its dry part which adjoins the surface of the water. Average fertility is about 70 to 110 eggs per spawn (Lacour et al., 2010). After a few days or months (diapause), the egg, put in water by the bad weather, hatch and the larva develops. The presence of deciduous leaves helps development which lasts five to 15 days depending on temperature. This development stops at 9 to 13 °C (Roiz et al., 2010). The larvae then transform into a nymph from which an adult will emerge. This larva will live about two weeks in summer at two months in the cool period. The females will bite every three to four days for ripening their eggs although they may sting daily (Lacour et al., 2010).

The diurnal activity of this mosquito makes it a difficult to avoid. In the southeast of France, it is not uncommon to find yourself with dozens of individuals ready to bite you. The lesions caused are those of common mosquitoes, that is to say, an erythematous and pruritic tablet at the site of the puncture, occurring within a few minutes. In some individuals, the intensity of the local reaction may cause a bubble. There are few studies on the impact of these mosquitoes on local populations. Curco et al. (Curc6 et al., 2008) in Spain have shown the importance of this impact in terms of quality of life in a

population. A questionnaire was sent to 309 people from their health center on the characteristics of the bites caused by these mosquitoes: 91% of the responders knew the Tiger mosquito. 61% of them reported having suffered punctures.

The aim of this study is to review the recent expansion of *Ae. albopictus* in North Africa and examined the factors influencing mosquitoes' invasion.

2. History of *Aedes aegypti* and *Aedes albopictus* in North Africa

Aedes aegypti and *Ae. albopictus* transmit several viral diseases essentially yellow fever virus, dengue virus chikungunya virus and Zika virus (Bonizzoni et al., 2013; Paty et al., 2014). Both species develop mainly in container-breeding mosquitoes and are very associated to humans. *Aedes aegypti* are endophiles and occupy the urban environments of high population density. *Aedes albopictus* prefers rural and suburban places. Both species develop in the same breeding sites where they live together (Braks et al., 2003).

Historically, *Ae. aegypti* is transmitted from one continent to another through via ship which caused an important risk of introducing this mosquito in Europe. The change of its domestic behavior in West Africa has allowed *Ae. aegypti* to spread widely and invade the tropical regions, hence the high risk of transmitting several inter-human arboviruses such as dengue (Weaver and Reison, 2010). *Aedes aegypti* is present in all regions with an annual average temperature of more than 20 ° C, i.e. in many parts of the world. *Aedes Aegypti* was harvested in the lower regions of Mediterranean Africa and in several coastal cities from Morocco to Egypt (Figure 1) (Brunhnes et al., 2000).

All continents are already colonized by *Ae. albopictus* except Antarctica, over the past 30-40 years. Since its appearance in Brazil and Mexico in the 1980s, this mosquito continues to colonize different parts of the continent: Central and South America, North America (Bonizzoni et al., 2013). In 1990, *Ae. albopictus* colonized the African continent: Nigeria, Cameroon, Equatorial Guinea, Gabon, the Central African Republic and the Republic of Congo (Ngoagouni et al., 2015). Mozambique recently declared the existence of *Ae. albopictus* in its territory (Kampango & Abílio, 2016). Albania was the first European country colonized by this mosquito in 1979 to disperse thereafter in the majority of European countries which include the countries closest to the Maghreb (Medlock et al., 2015).

Despite the important aerial and maritime links between northern coasts of the Mediterranean basin and Southern Europe which are characterized by *Ae. albopictus* colonization, this mosquito has been detected in just two countries of northern Africa (Figure 1). In Algeria, identification of *Ae. albopictus* was carried out in 2010, 2014 and 2015 (Izri et al., 2011; Lafri et al., 2014;

Benallel et al., 2016). In Morocco, the detection of this mosquito in three breeding sites in the same province of Rabat in 2015 and the claim of their nuisance by the population confirm the beginning of the establishment of this new species in the country (Bennouna et al., 2017). The collection of two larvae and three pupae in bromeliad plants and of 19 adults using insect aerial netting in 2016 confirm the previous conclusions.

This new species will rapidly invade the other countries of northern Africa given the important aerial and maritime links with Southern Europe, countries already infected. In fact, the establishment of this mosquito has enabled the activation of chikungunya in Italy and dengue in France (Angelini et al., 2007; Succo et al., 2016). The detection of *Ae. albopictus* in Algeria and Morocco is a major public health problem by increasing the risk of the creation of endemic foci of transmission following the increase of imported cases. The reinforcement of border surveillance is necessary to prevent the penetration of these viruses.



Figure 1. A North Africa map of *Aedes aegypti* and *Aedes albopictus* (Brunhnes et al., 2000; Izri et al., 2011; Lafri et al., 2014; Benallal et al., 2016; Bennouna et al., 2017)

3. Conclusion:

The data below show that the risk of introduction of many virus transmitted by this insect becomes real and must be taken into account especially with the vectorial competence of this dangerous vector. Mobilization entomologist is required to end the mapping of areas colonized by this insect in all the countries of Northern Africa. As recently pointed out (Paupy et al, 2009), in all countries where *Ae. albopictus* circulates there is an urgent need to case mapping and monitoring of vector control coverage to prevent onward transmission among the local population.

Conflicts of Interest:

Authors declared no conflicts of interest.

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