



Outcome of Some of the Many *Aedes Albopictus* (Skuse, 1895) Mosquito Encounters with Man

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Abstract

Aedes albopictus, the Asian tiger mosquito, has lately become prominent, globally, while showing a marked "migratory" capacity. We have scrutinized the many consequences of the encounters between the Asian tiger mosquito and humans, and have chosen to review several of them. It seems inevitable that this mosquito be more and more present in our lives. It is a tremendous nuisance to man through its bite. However, several arboviral infections are the main consequences of these confrontations, encompassing all ranges of severity. Few means of prevention, however, have proven successful.

Keywords

Aedes albopictus, Asian tiger mosquito, Arboviral infections, Chikungunya, Dengue, Yellow fever

Introduction

The Asian tiger mosquito, the *Aedes albopictus* (*Ae. albopictus*) (Skuse, 1895) (Diptera: Culicidae) originates, as expected from its current name from the Far East. Its "tiger" surname was given to it, due to white dots on its legs and white bands on its body. Although a small insect, usually less than one centimeter in length, the *Ae. albopictus* is a huge nuisance to mammals and especially to man, but it has been considered to feed also, to some extent on birds. It seems that foraging by the female *Ae. albopictus*, occurring during day light hours, is for the least, unpredictable.

The Asian tiger mosquito flies no more than 100-200 m at one time. Nevertheless, it is one of the most invasive of mosquitoes, being today widespread to most areas of the globe. Its spreading capacity is basically of a passive nature, as by proliferating in small water collections in old tires. The Asian tiger mosquito has been responsible, among many others, for the propagation of two arboviral infections, chikungunya and dengue. It seems that for both these viral infections, *Aedes egypti*, predominates as a vector over *Ae. albopictus*. It is generally agreed upon that the Asian tiger mosquito plays little or no role in the malaria and the West Nile virus fever pathogenesis.

In this text, we present an overview of particular facets of the

interaction between the *Ae. albopictus* and humans, while a fierce migration of the insect is taking place.

Aedes Albopictus (Skuse, 1895)

The *Ae. albopictus* has progressively invaded temperate regions of Europe and of the Americas. The mosquito is the cause of severe nuisance and may transmit several arboviral infections. Its capacity to harm humans may be related with the age of the insect, irrespective of its physiological status [1]. So far, European countries confirm that the most frequent arboviral diseases transmitted by the *Ae. albopictus* mosquito are due to imported cases [2,3].

The introduction of *Ae. albopictus* into Southern Europe occurred around the 1980s [4]. By now, the Asian tiger mosquito has been identified as one of the fastest spreading of all and one of the world's worst invasive alien species [5,6]. An increased colonization of urban areas in Europe, related with a preference with the *Ae. albopictus* for shaded areas has been observed [7]. The anthropophilism of the *Ae. albopictus* is maximal in high density urban areas and decreases progressively with increasing vegetation. The "migratory" propensity of *Ae. albopictus*, being in fact more of a passive process, together with its being a vector for several arboviruses, determines its transformation into a severe public health hazard [8].

Aedes albopictus was found in Israel to breed in tree holes adequately shaped to retain water for long enough periods [9]. Among the many attractant products for the Asian tiger mosquito, an interesting one has been found to be the carob seed pod, which represents a rich source of sugar for the mosquito [10].

The *Ae. albopictus* is believed to be ubiquitous, mainly foraging on mammals, mostly humans, but only very occasionally on birds. A recent study did not find evidence of avian-related blood among 165 blood meals detected in the Asian tiger mosquito [11]. This might preclude dissemination of the *Ae. albopictus* by bird migration. Female *Ae. aegypti* which are also invasive, showed feeding inhibition, both for sugar and blood, when exposed to male *Ae. albopictus*. In contrast, the female Asian tiger mosquito foraging did not suffer from exposure to males of either species. This may be one important mechanism of displacement of *Ae. aegypti* by the Asian tiger mosquito [12].

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High temperature and poor feeding during development of mosquitoes will usually result in small adults. The frequency of blood meals and of host seeking is inversely correlated with body size for the *Ae. albopictus*. This results in small mosquitoes having more contacts with the host [13]. A marked increase in a large variety of mosquito species is occurring in Europe and the USA. Many of them belong to the same invasive species as the Asian tiger mosquito.

Arboviral Infectious Diseases

Dengue and chikungunya

These two mosquito-borne viral diseases are spreading persistently around the globe. Dengue, a frequent febrile illness in the tropical areas of Africa, is now disseminated to the Americas and this encompasses all the four serotypes of the dengue virus. This disease has also reached areas in Southern Europe during the summer [14].

Dengue belongs to the Flavivirus group of zoonoses, together with yellow fever and Zika fever. Their transmission includes primates as reservoirs and *Aedes* mosquitoes as vectors. However, human-to-human transmission has also been reported [15]. As a rule, dengue is a mild acute febrile disease and may present with headache and myalgia (now defined as "dengue"). In some cases, more frequently in children, the disease will present with abdominal pain, lethargy, bleeding, hepatomegaly and thrombocytopenia. These symptoms and signs herald a severe development, often lethal ("severe dengue") [16]. All ranges of hepatotoxicity may be found [17].

The chikungunya virus, originating from Central Africa (isolated cases and small outbreaks) or from Asia (large epidemics), has disseminated recently, first to islands of the Indian Ocean, then, to the Indian Subcontinent and to Italy. Last, it has reached the American continent, via the Caribbean.

Aedes aegypti predominates as the vector of both viruses. However, *Ae. albopictus* catches up rapidly, promoting their spread in temperate climate. Among the main factors fostering the spread of both viruses, are improved viral fitness, changes in global climate and increased urbanization [14].

Chikungunya is a rapidly emerging arboviral disease caused by an Alphavirus of the Togaviridae family. The patient temperature rises rapidly, accompanied by a symmetrical arthralgia and often by extreme fatigue. Relapses are frequent. Currently, this infectious disease is being reported globally [18].

Yellow fever

Yellow fever is caused by a Flavividae arbovirus, transmitted by *Aedes* mosquitoes. This has occurred mainly in Africa. In Central Africa, *Ae. aegypti* is the main vector of yellow fever in urban areas. However, *Ae. albopictus* is also significantly involved [19]. On the other hand, one of the main factors why yellow fever and dengue coexist in some parts of the world (Africa), but not in others (Asia): in Africa, *Ae. albopictus* which competes with *Ae. aegypti*, shows a relatively low prevalence. While the Asian variant of *Ae. aegypti* is to some degree incompetent in transmitting yellow fever [20]. Nevertheless, *Ae. albopictus* has largely replaced *Ae. aegypti* in Europe [21] and in the Americas [22].

Zika virus

The Zika virus had been isolated in several genera of mosquitoes and in non-human primates of the African and Asian forests for many years. However, recently reported epidemics, starting from Micronesia in 2015 and reaching the Northeastern areas of Brazil, Central America and the Caribbean have occurred. It is transmitted by infested *Ae. aegypti* and *Ae. albopictus* [23]. Isolated cases imported from Polynesia were described in Italy.

The clinical picture includes low grade fever, malaise, conjunctivitis, myalgia, arthralgia and lymphadenopathy. In these cases, the sera are diagnostic and show a cross-reactivity with dengue virus antigens. In this study, the vector was most frequently the

Ae. albopictus [24]. This association was confirmed in recent Zika fever cases from Gabon, highlighting the presence of the Asian tiger mosquito in Africa [25]. In the last several few months, involvement of the Zika virus in complications of the contamination of pregnant women in Venezuela and Brazil has been reported. These women gave birth to new born babies with congenital malformations, mainly microcephaly and with failure to thrive [26].

La crosse encephalitis

This is one of the most frequent causes of pediatric arboviral encephalitis in the USA. First described in Tennessee in 1997, it is transmitted, in addition to autochthonous vectors (*Ae. triseriatus*), by *Ae. albopictus* and *Ae. Japonicus* [27,28].

Microfilarial infections

Several species of microfilaria are transmitted by mosquitoes. *Dirofilaria* species are transmitted by mosquito bites and may cause the human pulmonary as well as several others lesions. The Asian tiger mosquito may play an important role in this contamination [29-32].

Malaria and west nile virus fever

Aedes albopictus is not considered as a vector of malaria [33-35].

In spite of statements to the contrary [36], it seems evident that *Ae. albopictus* has not been recognized as a vector of the West Nile virus [37].

Nevertheless, as the Asian tiger mosquito invades Africa and in fact, the world, these statements may be altered.

Immunology of asian tiger mosquito

Using appropriate antibodies against *Ae. albopictus* salivary proteins, which reveal a strong antigenicity, allergic reactions occur, regardless of the means of exposure. Near 70% of these proteins are related with blood feeding, including adenosine deaminase and serpin [38].

Skin reactions are observed following mosquito bites which vary from the relatively innocuous mosquito allergy, due to reactions to the allergens in the mosquito saliva. This may include severe local, and at times systemic reactions to the bite [39].

On the other hand hypersensitivity to the mosquito bite, which is one form of the chronic active infections by Epstein-Barr virus (EBV) may be observed. This rare condition, affecting predominantly children and young adults, evokes, in addition to a severe local skin reaction, generalized symptoms, like high fever and regional lymphadenopathy, hepatosplenomegaly, and is sometimes associated with hematological malignancies [40-43]. This reaction may be due to an antigen-induced activation of basophils or mast cells by a mosquito associated IgE.

Unlike mosquito allergy which is an immediate allergic skin reaction, IgE-dependent, hypersensitivity to mosquito bites causes severe symptoms resulting probably from mosquito-related CD4+ T cells and EBV-infected NK cells [44].

Conclusions

Aedes albopictus (Skuse, 1895) (Diptera: Culicidae) presents several peculiarities, the most striking being a "migratory" capacity, rarely equaled but in fact a passive process. In addition the *Ae. albopictus* may lay its eggs in small pockets of water, as in used tires or hollow trees. Redistribution of the tires may promote dissemination. The mosquito causes a severe nuisance, but most arboviral infectious diseases carried by this species, are more critical, though of variable severity. This mosquito's bite, like that of many others, may cause a simple mosquito allergy and in a minority of victims, hypersensitivity to mosquito bites, which is associated with EBV infection, a severe local and systemic reaction and at times with hematological malignancies.

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Conflict of Interest

The authors have declared: "that no conflict of interest exists".

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