IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)
e-ISSN: 2278-3008, p-ISSN:2319-7676. Volume 10, Issue 6 Ver. IV (Nov - Dec. 2015), PP 05-09
www.iosrjournals.org

Aedesalbopictus: Portrait of a potential vector

Mohona Gupta and Sajal Bhattacharya
Department of Zoology,Asutosh College (University of Calcutta)92, SP Mukherjee RoadKolkata-700026, India

Abstract: *First reported from Bengal, Aedesalbopictus has successfully invaded most of the inhabited regions of the world. Hence, it is aptly referred to as a 'global vector'. Their potential as a disease vector cannot be repudiated.This species has been included among the hundred most dangerous species in the global invasive species database.Carrying viruses for several diseases such as Chikungunya, dengue, yellow fever,Aedesalbopictus has proven to be a highly potential disease vector. Apart from viruses, certain filarial nematodes have also been detected from this mosquito species. Its genetic makeup remarkably supports intraspecific variation.*

Keywords: *Aedesalbopictus, vector, disease, bioecology, globalization*

I. Introduction

Aedesalbopictus or *Stegomyiaalbopicta* is currently one of the most flagrant and globally meddling mosquito species, belonging to family Culicidae[1] Popularly known as the Asian tiger mosquito or the forest mosquito, it is characterized by its black and white striped body but what distinguishes it from other species having the same morphological characters is the presence of a median silver scale on the dorsal region of thorax or scutum.[2]It is native to Southeast Asia and was first described from Bengal in the Indian subcontinent ("the banded mosquito of Bengal"[3]). This species has been rightly called a 'global vector' because it has originated from one place and has successfully invaded all the habitable continents of the world.[4]The epidemiological importance has been attributed to its role as a vector of several arboviruses of public health importance[5]. Certain filarial nematodes such as the *Dirofilariaimmitis* has also been carried by *Aedesalbopictus*[6].In the global invasive species database, it has been included among the 100 most dangerous species and stands first in the public health sector.[7]*Aedes albopictus* prefers a vegetative habitat and acts as a secondary/maintenance vector for dengue [8] but in the recent past *Aedesalbopictus* was found to be the primary vector of dengue in Kerala, India. The various reasons which contribute to the ecological flexibility of this species include primarily photoperiodic diapause and desiccation resistant eggs.[9]

II. Globalization

Originating from Southeast Asia, *Aedesalbopictus* has reached all corners of the world where human habitation is possible. One of the major means of its distribution is the international trade in used tyres. *Aedesalbopictus* was originally an inhabitant of Asia. Nowadays, it is found in all the majorly inhabited regions of the world. This includes America, Europe and Africa where international trade is maximized.[10]Until 2005, *Aedesalbopictus* had not been recorded in the Australian mainland but in the recent past its existence in Papua New Guinea [11]and Daru island[12] has accelerated the risk of its spread to the mainland [13]

Aedesalbopictus occurs in patches across the Northern Pacific Island Countries and territories. For example, its presence is witnessed in Taiwan but not in Yap even though there is a consistent trafficking of visitors.[14]It is absent or negligible in the South Pacific region. A major cause for this is that *Aedesalbopictus* is not efficient enough to compete with the *scultellaris* group. [15]It has been inferred that the arrival of this mosquito species is somehow associated with the reducing number of *Aedesaegypti* species. Several possible explanations have been put forth regarding the competitive exclusion of *Aedesaegypti* by *Aedesalbopictus* mosquito. First, a remarkably low fitness rate has been observed in *Aedesaegypti* over *Aedesalbopictus*. Second, with respect to the larval resources, *Aedesalbopictus* has proven to be far moresuperior than*Aedesaegypti*. Third,interspecific mating results in offspring sterility. [16]

III. Bioecology

Aedesalbopictus is known to breed well in both natural as well as artificial habitats such as tyres, drinking troughs, rainwater catch basins, and so on but they do not breed in brackish or salt water. [17]

Aedesalbopictus has proven to be a clear winner while competing for food resources with other species such as *Aedes japonicas* and *Aedes triseriatus*[18]

Aedesalbopictus feeds in the day. It is usually found to rest in shrubs near the ground and is abundant in shady areas.[19]Study has revealed that the peak timings of feeding for this species is early in the morning and late in the

afternoon. Researchers described its biting behavior as aggressive and opportunistic having a wide host range.[20]Although this species spends the winter in the egg stage in temperate climate[21], it remains functional all year round in the tropical and subtropical areas. Eggs are usually singly laid[22], black in color, oval in shape and measures 0.5mm in length. The eggs have the capacity to withstand desiccation up to a year. The larval emanation occurs when the level of water rises in containers after rainfall. Several submersions of the eggs are required before the egg can hatch. In addition to this, low oxygen tension significantly enhances the hatching of eggs.[23]The egg diapause phenomenon is also closely related to the duration of day light. The short day length exposure of the maternal pupa and adult triggers the initiation of diapause of larvae inside the egg's chorion.[24,25] Diapause ensures that the eggs of these species are drought resistant and have the ability to withstand the cold temperatures of winter.[26] These two factors may play an important role in the globalization of *Aedes albopictus*.[27]Although development is dependent on temperature, the fact remains that the larvae pupate only after five to ten days.The pupal stage stays for two days.[28] The larva or wigglers being active feeders, feed on fine organic substances present in water and use a siphon to breathe in oxygen when they go to the surface of water periodically. Unlike many other insects, the pupae in this case are short lived but active, motile but do not feed.[29]

Temperature and availability of food and water resources in a defined geographical area dictates the seasonal abundance of the species. Larval development is directly proportional to temperature, thereby accelerating the adult population number, development of immatures in autumn and eventually overwintering of eggs. [30]*Aedesalbopictus* is multivoltine in nature with approximately five to fourteen generations per year. [31]

Evidences regarding host preference of *Aedesalbopictus* has been found from a study in Italy clearly indicating the affinity of this species towards mammals over birds. Moreover human blood meals were found in greater abundance in urban areas than in rural areas . This suggests that there is a direct impact on the feeding behaviour of *Aedesalbopictus*precisely by availability and abundance of hosts.[32]

Aedesalbopictus has a habit of biting humans during daytime. This is not only annoying but also proves to be harmful because this mosquito species is a vector to several viral diseases such as dengue, chikungunya and yellow fever.[33]

In addition to the above mentioned virus, several other viruses have been isolated from this mosquito species such as West Nile, La Crosse, Catchey valley virus, Tensaw, Potosi and Keystone Eastern equine encephalitis. The detection of a virus from a particular species does not necessarily make it a vector. The attainment of the status of being a vector is a dynamic phenomenon and there is a possibility that with the passage of time, this particular mosquito species molds itself in epidemiologically important ways to carry some of the above mentioned viruses as vectors. [34]

Aedesalbopictus was the sole vector responsible for the spread of chikungunya virus in places like the La Reunion and certain islands of the Indian Ocean. (Table 1, Table 2)

Table 1: Involvement of *Aedesalbopictus* in the incidence of Dengue and Chikungunya

Disease	**Region affected**
Dengue	Japan (1942-1945) [35]
Dengue	Hawaii(2001) [36]
Dengue	La Reunion (1977-78) [37]
Dengue	La Reunion (2004) [38]
Chikungunya	La Reunion (2005-06) [39]
Chikungunya	Italy (2007)40
Chikungunya	Southern France (2010) [41]
Dengue, Chikungunya	Central Africa [42]

Table 2: Some of the viruses isolated from *Aedesalbopictus*[43,44]

Dengue	Chikungunya	West Nile
Yellow fever	La Crosse	Catchey valley virus
Tensaw	Potosi	Keystone equine encephalitis

Deforestation has also contributed significantly in the invasion of *Aedesalbopictus* species. It creates new ecological niches for the vectors along with its pathogens which gives a new dimension to the transmission dynamics of the diseases. The human populations which settled in these regions will be highly susceptible to these endemic zoonotic pathogens because the newly settled populations lack immunity to the invaded pathogens. In order to cope with the changing ecological conditions, certain vectors are seen to convert from a primary zoophilic to primary anthropophilic habit as a result of the reverse situation of human and animal population density.[45]Mosquitoes exploited all available niches created by man and also by natural calamity. [46]In comparison to *Aedesaegypti*, *Aedesalbopictus* is less anthropophilic.[47]A rise in A*edesalbopictus*population both

in rural and urban areas enhances more *Aedesalbopictus* / man contact, even more when the preferred host is lacking.[48]

A study of *Aedes* mosquito species in Kolkata and adjoining areas suggested that *Aedesalbopictus* began invading the urban areas although *Aedesaegypti* was still dominant. *Aedesaegypti* was also found in the suburban and rural areas though *Aedesalbopictus* continued to dominate in those areas.[49]

IV. Intraspecific Variation

In the course of evolution, several protein and RNA sequences remain conserved but each taxa format their genomes in distinct ways for expression, transmission and replication. The nature of signals that dictate the transcription of different genetic loci marks the foundation of genome system architecture.[50]

One major cause leading to the intraspecific variation of the two strains of this species is the high repetitive DNA. A remarkable correlation has been drawn between the size of genome and the generation time period in *Aedesalbopictus* population.[51] Repetitive DNA sequences are responsible for deciphering various aspects like genome expression and even transmission. In addition to this, the formation of nucleoprotein complex entitled to perform the basic genomic operations is also enhanced by these sequences. [52] There is a possibility that the alteration of the repetitive DNA sequences might affect the transmission of genome without affecting phenotype. This may in turn play a pivotal role in evolutionary diversification. Such alterations have a potential to bring in reproductive isolation[53].

V. Conclusion

Aedesalbopictus is a highly potential disease vector of dengue, chikungunya and yellow fever**. I**t has the necessary ecological flexibility to adapt to the changing environment. This has led to the spread of this species to all the habitable continents of the world. Its role in the disease transmission cycle may pose a tangible threat to public health. Isolation of a virus from a mosquito does not necessarily make it a vector. There are several other factors required to attain the status of a vector. With the passage of time, *Aedesalbopictus* may become epidemiologically significant for some of those isolated viruses which are having an insignificant public health importance at present.

Another point which cannot be ruled out is that considering its adaptive fitness and invasive behaviour, *Aedesalbopictus* may be used as a tool in bioterrorism. A simple introduction of this species carrying a certain virulent strain of virus into an area which was earlier not inhabited by this species, could be detrimental.

This is precisely why *Aedesalbopictus* must be under constant surveillance and sustained control measures should be taken especially from the public health and even security point of view.

Reference

[1]. [1] Animal diversity Web Aedesalbopictus. Available at http://animaldiversity.org/accounts/Aedes_albopictus/classification/ , accessed on November 2, 2015.

[2]. [2]ECDC (European Centrefor Disease Prevention and Control)\ . Available at http://ecdc.europa.eu/en/healthtopics/vectors/mosquitoes/Pages/aedes-albopictus.aspx, accessd on November 17, 2015.

[3]. [3]Skuse, F.A.A. (1894). The banded mosquito of Bengal. Indian Museum Notes 3(5):20.

[4]. [4] Bhattacharya S. (2013) The Globalisation of a vector: exploring the threats with special reference to dengue. In Proceedings of the Brain Storming Conference on Dengue Scenario in India: Disease Burden, Surveillance and Control (July25-26,2013; Madurai), Editor: B.K.Tyagi, published by Centre for Research in Medical Entomology, Madurai.

[5]. [5]Hochedez, P. et al. (2006). Chikungunya Infection in Travelers .*Emerging Infectious Diseases* **12** (10): 1565–1567.

[6]. [6]Cancrini G, Frangipane di Regalbono A, Riccia I, Tessarin C, Gabrielli S and Pietrobelli M (2003). Aedesalbopictus is a natural vector of Dirofilariaimmitis in Italy. *Veterinary Parasitology* **118** (3–4): 195–202.

[7]. [7] WHO (2011). European Mosquito control Association: Guidelines for the control of invasive mosquitoes and associated vetor-borne diseases on the European continent. Retrieved June 18 ,2013 from http://www.emca-online.eu/documents/visitors/WHO2011_revised.pdf

[8]. [8]Bhattacharya S. (2011). Challenges of Mosquito-borne diseases in the changing ecological conditions. Journal of the Asiatic Society L(3): 109-118

[9]. [9]Contra 1

[10]. [10]Benedict MQ, Levine RS, Hawley WA, Lounibos LP (2007): Spread of the tiger: global risk of invasion by the mosquito *Aedesalbopictus*. *Vector Borne Zoonotic Dis* , **7:**76-85.

[11]. [11]Richard CR, Craig RW, Robert WS, Scott AR. Aedes (Stegomyia) albopictus- a dengue threat for southern Australia? CDI VOl 29 No 32005, pg:296-298.

https://www.health.gov.au/internet/main/publishing.nsf/content/cda-cdi2903-pdf-cnt.htm/$FILE/cdi2903j.pdf

[12]. [12]contra 10

[13]. [13]contra 10

[14]. **[14]**Lauren Guillaumot, Reynold Ofanoa, Lucien Swillen, Narendra Singh**,** Hervé C Bossin and Francis Schaffner**. (2012)** Distribution of Aedesalbopictus(Diptera, Culicidae) in southwestern Pacific countries, with a first report from the kingdom of Tonga. *Parasites & Vectors* 2012, **5**:247 doi:10.1186/1756-3305-5-247 .Available athttp://www.parasitesandvectors.com/content/5/1/247**,** accessed on November 17,2015**.**

[15]. [15]Belkin JN (1962): *The mosquitoes of the South Pacific*. Univ. Calif. Press, Berkeley and Los Angeles.

[16]. [16]Darsie RF, Ward RA. (2005). Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico. University of Florida Press, Gainesville, FL. 300 pp.

[17]. [17]Buhagiar JA (2009). A second record of *Aedes (Stegomyia)albopictus* (Diptera: Culicidae) in Malta. European Mosquito Bulletin. 2009; 27:65-7.

[18]. [18]Leisnham PT, Juliano SA (2012) Impacts of climate, land use, and biological invasion on the ecology of immature Aedes mosquitoes: implications for La Crosse emergence. EcoHealth. 2012 Jun;9(2):217-28.

[19]. [19]Koehler PG, Castner JL. (1997). Blood sucking insects. *EDIS*. Retrieved 21 January, 2004, available at http://edis.ifas.ufl.edu/IN019 , accessed on November 15, 2015.

[20]. [20]Hawley WA. (1988). The biology of *Aedesalbopictus*. Journal of the American Mosquito Control Association. Supplement #1. p. 1-40.

[21]. [21]Lyon WF, Berry RL. (1991). Asian tiger mosquito. Ohio State University Extension Fact Sheet HYG-2148-98

[22]. [22]Hawley WA. (1988). The biology of *Aedesalbopictus*. Journal of the American Mosquito Control Association. Supplement #1. p. 1-40.

[23]. [23]Contra 19

[24]. [24]Mori A, Oda T, Wada Y (1981): Studies on the egg diapause and overwintering of *Aedesalbopictus* in Nagasaki. Tropical Medicine, 23:79-90.

[25]. [25]Wang RL (1966): Observations on the influence of photoperiod on egg diapause in *Aedesalbopictus*Skuse. ActaEntomologicaSinica 15:75-77.

[26]. [26]Rezza G. (2012). *Aedesalbopictus* and the re-emergence of Dengue BMC Public Health 2012, 12:72

[27]. [27]Urbanski J, Benoit J,Michaud M, Denlinger D, Armbruster P(2010): The molecular physiology of increased egg desiccation resistance during diapause in the invasive mosquito *Aedesalbopictus. Proceedings of the Royal Society Biological sciences, 277:2683-2692.*

[28]. [28]Contra 11

[29]. [29]Featured Creatures: common name- Asian tiger mosquito , scientific name- *Aedesalbopictus* , (Skuse) (Insecta: Diptera: Culicidae). Available at http://entnemdept.ufl.edu/creatures/aquatic/asian_tiger.htm , accessed on November 15, 2015.

[30]. [30]Medlock JM, Avenell D, Barrass I, Leach S. (2006)Analysis of the potential for survival and seasonal activity of*Aedesalbopictus* (Diptera: Culicidae) in the United Kingdom. J Vector Ecol. 2006 Dec;31(2):292-304. Available at http://ecdc.europa.eu/en/healthtopics/vectors/mosquitoes/Pages/aedes-albopictus.aspx#sthash.q1N8W2Ty.dpuf , accessed on November 10, 2015.

[31]. [31]Gatt P, Deeming JC, Schaffner F. (2009) First records of Aedes (Stegomyia) albopictus (Skuse) (Diptera: Culicidae) in Malta. European Mosquito Bulletin 2009;27 56-64. Available at http://ecdc.europa.eu/en/healthtopics/vectors/mosquitoes/Pages/aedes-albopictus.aspx#sthash.q1N8W2Ty.dpuf , accessed on November 8,2015.

[32]. [32]Valerio L, Marini F, Bongiorno G, Facchinelli L, Pombi M, Caputo B, et al. (2010) Host-feeding patterns of Aedesalbopictus (Diptera: Culicidae) in urban and rural contexts within Rome province, Italy. Vector Borne Zoonotic Dis. 2010 Apr;10(3):291-4. Available at http://ecdc.europa.eu/en/healthtopics/vectors/mosquitoes/Pages/aedes-albopictus.aspx#sthash.q1N8W2Ty.dpuf , accessed on October 16,2015.

[33]. [33]Spread of the Tiger : Global Risk of Invasion by the Mosquito *Aedesalbopictus. Available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2212601/* , accessed on August 15,2015.

[34]. [34]Contra 1

[35]. [35]Kuno G (2007): Research on dengue and dengue-like illness in East Asia and the Western Pacific during the First Half of the 20th century.*Rev Med Virol*, 17:327-341.

[36]. [36]Effler PV, Pang L, Kitsutani P, Vorndam V, Nakata M, Ayers T, Elm J, Tom T, Reiter P, Rigau-Perez JG, *et al*(2005): Dengue fever, Hawaii, 2001–2002.*Emerg Infect Dis*, 11:742-749.

[37]. [37]Michault A (1998): Insulariteetrisquesepidemiques a La Reunion.*Bull SocPatholExot* , 91:52-55.

[38]. [38]Pierre V, Thiria J, Rachou E, Lassalle C, Sissoko D, Renault P(2006): Dengue fever outbreak in La Réunion Island in 2004. In *Poster International congress "Medicine and health in the tropics"*. Edited by

Pierre V, Thiria J, Rachou E, Lassalle C, Sissoko D, Renault P. International Water Association Publishing, Marseille.

[39]. [39]Reiter P, Fontenille D, Paupy C (2006): *Aedesalbopictus* as an epidemic vector of chikungunya virus: another emerging problem? *Lancet Infect Dis*, **6:**463-464.

[40]. [40]Angelini P, Macini P, Finarelli AC, Pol C, Venturelli C, Bellini R, Dottori M (2008): Chikungunya epidemic outbreak in Emilia-Romagna (Italy) during summer 2007.*Parassitologia* , 50**:**97-98.

[41]. [41]Grandadam M, Caro V, Plumet S, Thiberge JM, Souares Y, Failloux AB, Tolou HJ, Budelot M, Cosserat D, Leparc-Goffart I, Despres P(2011): Chikungunya virus, southeastern France. *Emerg Infect Dis* , **17:**910-913.

[42]. [42]Paupy C, Ollomo B, Kamgang B, Moutailler S, Rousset D, Demanou M, Herve JP, Leroy E, Simard F(2010): Comparative role of *Aedes*albopictus and *Aedesaegypti* in the emergence of Dengue and Chikungunya in central Africa**.** *Vector Borne Zoonotic Dis* , **10:**259-266.

[43]. [43] Contra 38

[44]. [44] Contra 39

[45]. [45]Ozer N. (2005). Emerging Vector-borne Diseases in a Changing Environment. Turk J Biol. 29,125-135.

[46]. [46]Contra 8

[47]. [47]Rezza G. (2012). Aedesalbopictus and the re-emergence of Dengue BMC Public Health 2012, 12:72

[48]. [48]Contra 1

[49]. [49] S Bhattacharya, D K Srivastava, A K Mandal.(2013) Studies on The Vectors of Dengue in the Context of Changing Epidemiology. *Sci. & Cult.* 79 (9–10) 391-395 (2013)

[50]. [50] Shapiro JA, Sternberg RV (2005) How repeated retroelements format genome function. Cytogenet Genome Res 110:108–116 (2005) also available at http://shapiro.bsd.uchicago.edu/Sternberg&Shapiro2005.pdf

[51]. [51] Rai K.S. and Black W.C IV (1999) Mosquito genomes:structure, organization and evolution. Adv.Genet. 41,1-33.

[52]. [52] Shapiro J.A and Sternberg RV, (2005) Why repetitive DNA is essential to genome function , Biol.Rev., 80, pp.1-24

[53]. [53]Hawley WA. (1988). The biology of *Aedesalbopictus*. Journal of the American Mosquito Control Association. Supplement #1. p. 1-40.