Invasive Aedes albopictus in the Americas

Subjects: Entomology

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Aedes (Stegomyia) albopictus Skuse is a mosquito native to Southeast Asia. Currently, it has a wide distribution in America, where natural infection with arboviruses of medical and veterinary importance has been reported. In the Americas, Ae. albopictus occupies the same ecological niches as Aedes (Stegomyia) aegypti. It is difficult to incriminate the Asian mosquito as the cause of autochthonous arbovirus outbreaks. However, evidence suggests that Ae. albopictus is very effective in transmitting endemic arboviruses (such as dengue) in both horizontal and vertical transmission. Aedes albopictus could be useful as a sentinel species to monitor dengue virus in interepidemic periods.

Emerging arboviruses | Asian tiger mosquito | Spatial distribution

1. Introduction

Aedes (*Stegomyia*) *albopictus* Skuse is a mosquito native to Southeast Asia, colloquially known as the Asian tiger mosquito or Asian mosquito. The mosquito was described by Skuse (1894) in the city of Calcutta, India [1][2]. At the beginning of 2000's, its importance as a vector of arboviruses was restricted to Asian and African countries [1]. Currently, *Ae. albopictus* is present on all continents except Antarctica [3]. It has been observed that once established in new geographic areas, it can become involved in the natural cycles of arbovirus transmission. For example, in Europe it has colonized several countries and was involved in dengue outbreaks in France, Italy, and Spain [4][5][6]. In Italy, the genome of the chikungunya virus was identified in *Ae. albopictus* and it was incriminated as the vector that caused the local outbreaks of chikungunya fever [7]. Likewise, autochthonous cases of Zika fever occurred in France and *Ae. albopictus* was suspected as the transmitter of the virus [8]. In America, dengue virus is the most important mosquito-borne viruses in terms of its global impact on human morbidity and mortality. Approximately 23 million dengue cases were registered across the Americas between 1980 and 2017. In 2019 there was a resurgence of the dengue virus, reaching 3.1 million cases throughout the region [9]. Chikungunya and Zika viruses are emerging viruses in America that have caused explosive outbreaks from 2013 to 2016, which has since subsided [10]. *Aedes aegypti* is the main vector of dengue, Zika, and chikungunya viruses in the region [10][11][12][13][14]. The antecedents demonstrate that *Ae. albopictus* can transmit these viruses [5][7][11][14]; therefore, it is considered a species with the potential to increase the risk of arbovirus transmission in America.

2. Chronological Order of the First Reports of *Ae. albopictus* in the Americas

The current distribution of *Ae. albopictus* encompasses 21 of 44 countries in the Americas, although the colonization pattern is different in each country (**Table 1**) and Chile and Peru have not reported any data yet. Previously, Kramer and collaborators [3] conducted a global compendium of the distribution of *Ae. albopictus* and described its presence in 16 countries of the Americas. According to reports, the mosquito has presented an erratic distribution, but with great rapidity in its movement through America. The introduction of *Ae. albopictus* in America was divided into four periods. In the first period (1983–1990), the Asian mosquito was reported in three countries. The first report occurred in the USA in 1983, when a single adult of *Ae. albopictus* was captured in a cemetery in Memphis, Tennessee [15]. Three years later, five male and six female mosquitoes with similar characteristics to the Asian mosquito were captured and their identity was confirmed as *Ae. albopictus* in Brazil (1986) [16]. In Mexico, the Asian mosquito was reported for the first time in 1988: the larvae were collected in tires [17]. In the second period (1993–1998), the Asian mosquito was reported in six countries including the Dominican Republic, Cuba, Guatemala, the Cayman Islands, Colombia, and Argentina [18][19][20][21][22][23]. Reiter [15] mentions that *Ae. albopictus* was reported in Bolivia and El Salvador, but there are no reports that confirm this. Their presence in these countries is not currently recognized. In the third period (2000–2010), the mosquito significantly expanded its distribution to ten countries, including Bermuda, Canada, Trinidad and Tobago, Panama, Uruguay, Nicaragua, Costa Rica, Venezuela, Belize, and Haiti [24][25][26][27][28][29][30][31][32][33]. In the fourth period (2011–2021), the presence of the mosquito was only reported in Ecuador in 2017 and in Jamaica in 2018 [34][35]. It is well documented that the introduction of *Ae. albopictus* into America occurred through tires and bamboo stumps imported from Japan. It is also hypothesized that the massive distribution of the mosquito occurred through the export of used tires among countries in the Americas, Europe, and Asia [1][15][16][17]. Within countries, automobiles are believed to contribute to the distribution [36].

Table 1. Chronological summary of publications on the first reports of *Ae. albopictus* in American countries.

Year of the First Report	Country	Collected Stage of the Mosquito	Author
1983	USA	A single adult collected	[15]
1986	Brazil	Captured five males and six females	[16]
1988	Mexico	Larvae collected in tires	[17]
1995	Cuba	Larvae collected	[18]
1993	Dominican Republic	Larvae collected in tires	[19]
1995	Guatemala	Larvae were collected in tires, glass bottles, and metal drums.	[20]
1997	Cayman island	Larvae collected	[21]
1998	Colombia	Captured adults	[22]

Year of the First Report	Country	Collected Stage of the Mosquito	Author
1998	Argentina	Larvae and pupae collected	[23]
2000	Bermuda Island	Larvae collected	[24]
2002	Panama	Larvae collected	[25]
2001	Canada	Two adults captured	[26]
2002	Trinidad and Tobago	Eggs collected with ovitrap	[27]
2003	Uruguay	Adults captured	[28]
2003	Nicaragua	Larvae collected	[29]
2007	Costa Rica	Larvae collected	[30]
2009	Venezuela	Larvae collected	[31]
2009	Belize	Adults captured	[32]
2010	Haiti	Larvae collected	[33]
2017	Ecuador	Captured 5 males and 16 females	[34]
2018	Jamaica	Six females captured	[35]

References

1. Gratz, N.G. Critical review of the vector status of Aedes albopictus. Med. Vet. Entomol. 2004, 18, 215–227.
2. Watson, M.S. Aedes (Stegomyia) albopictus (Skuse): A literature review. Misc. Publ. 1967, 22, 1–38.
3. Kraemer, M.U.G.; Sinka, M.E.; Duda, K.A.; Mylne, A.; Shearer, F.M.; Brady, O.J.; Messina, J.P.; Barker, C.M.; Moore, C.G.; Carvalho, R.G. The global compendium of Aedes aegypti and Ae. albopictus occurrence. Sci. Data 2015, 2, 1–8.
4. La Ruche, G.; Souarès, Y.; Armengaud, A.; Peloux-Petiot, F.; Delaunay, P.; Desprès, P.; Lenglet, A.; Jourdain, F.; Leparc-Goffart, I.; Charlet, F. First two autochthonous dengue virus infections in metropolitan France, September 2010. Eurosurveillance 2010, 15, 19676.
5. Monge, S.; García-Ortúzar, V.; Hernández, B.L.; Pérez, M.Á.L.; Delacour-Estrella, S.; Sánchez-Seco, M.P.; Martinez, B.F.; San Miguel, L.G.; García-Fulgueiras, A.; Moros, M.J.S. Characterization of the first autochthonous dengue outbreak in Spain (August–September 2018). Acta Trop. 2020, 205, 105402.

6. Lazzarini, L.; Barzon, L.; Foglia, F.; Manfrin, V.; Pacenti, M.; Pavan, G.; Rassu, M.; Capelli, G.; Montarsi, F.; Martini, S. First autochthonous dengue outbreak in Italy, August 2020. Eurosurveillance 2020, 25, 2001606.
7. Bonilauri, P.; Bellini, R.; Calzolari, M.; Angelini, R.; Venturi, L.; Fallacara, F.; Cordioli, P.; Angelini, P.; Venturelli, C.; Merialdi, G. Chikungunya virus in Aedes albopictus, Italy. Emerg. Infect. Dis. 2008, 14, 852.
8. Giron, S.; Franke, F.; Decoppet, A.; Cadiou, B.; Travaglini, T.; Thirion, L.; Durand, G.; Jeannin, C.; L'ambert, G.; Grard, G. Vector-borne transmission of Zika virus in Europe, southern France, August 2019. Eurosurveillance 2019, 24, 1900655.
9. Salles, T.S.; da Encarnação Sá-Guimarães, T.; de Alvarenga, E.S.L.; Guimarães-Ribeiro, V.; de Meneses, M.D.F.; de Castro-Salles, P.F.; Dos Santos, C.R.; do Amaral Melo, A.C.; Soares, M.R.; Ferreira, D.F. History, epidemiology and diagnostics of dengue in the American and Brazilian contexts: A review. Parasit. Vectors 2018, 11, 1–12.
10. Vasconcelos, P.F.C.; Powers, A.M.; Hills, S. The emergence of Chikungunya and Zika viruses in the Americas. In Chikungunya and Zika Viruses; Elsevier: Amsterdam, The Netherlands, 2018; pp. 215–235.
11. Méndez, F.; Barreto, M.; Arias, J.F.; Rengifo, G.; Munoz, J.; Burbano, M.E.; Parra, B. Human and mosquito infections by dengue viruses during and after epidemics in a dengue–endemic region of Colombia. Am. J. Trop. Med. Hyg. 2006, 74, 678–683.
12. Díaz-González, E.E.; Kautz, T.F.; Dorantes-Delgado, A.; Malo-García, I.R.; Laguna-Aguilar, M.; Langsjoen, R.M.; Chen, R.; Auguste, D.I.; Sánchez-Casas, R.M.; Danis-Lozano, R. First report of Aedes aegypti transmission of chikungunya virus in the Americas. Am. J. Trop. Med. Hyg. 2015, 93, 1325–1329.
13. Cigarroa-Toledo, N.; Blitvich, B.J.; Cetina-Trejo, R.C.; Talavera-Aguilar, L.G.; Baak-Baak, C.M.; Torres-Chablé, O.M.; Hamid, M.N.; Friedberg, I.; González-Martinez, P.; Alonzo-Salomon, G.; et al. Chikungunya virus in febrile humans and Aedes aegypti mosquitoes, Yucatan, Mexico. Emerg. Infect. Dis. 2016, 22, 1804.
14. Huerta, H.; González-Roldán, J.F.; Sánchez-Tejeda, G.; Correa-Morales, F.; Romero-Contreras, F.E.; Cárdenas-Flores, R.; Rangel-Martínez, M.L.; Mata-Rivera, J.M.; Siller-Martínez, J.D.J.; Vazquez-Prokopec, G.M. Detection of Zika virus in Aedes mosquitoes from Mexico. Trans. R. Soc. Trop. Med. Hyg. 2017, 111, 328–331.
15. Reiter, P. Aedes albopictus and the world trade in used tires, 1988-1995: The shape of things to come? J. Am. Mosq. Control Assoc. 1998, 14, 83–94.
16. Forattini, O.P. Identificação de Aedes (Stegomyia) albopictus (skuse) no Brasil. Rev. Saude Publica 1986, 20, 244–245.

17. Ibáñez-Bernal, S.; Martínez-Campos, C. Aedes albopictus in Mexico. J. Am. Mosq. Control Assoc. 1994, 10, 231–232.
18. Broche, R.G.; Borja, E.M. Aedes albopictus in Cuba. J. Am. Mosq. Control Assoc. 1999, 15, 569–570.
19. Peña, C.J. First report of Aedes (Stegomyia) albopictus (Skuse) from the Dominican Republic. Vector Ecol. Newsl. 1993, 24, 68.
20. Ogata, K. Discovery of Aedes albopictus in Guatemala. J. Am. Mosq. Control Assoc. 1996, 12, 503–506.
21. Wheeler, A.S.; Petrie, W.D.; Malone, D.; Allen, F. Introduction, control, and spread of Aedes albopictus on Grand Cayman Island, 1997–2001. J. Am. Mosq. Control Assoc. 2009, 25, 251–259.
22. Vélez, I.D.; Quiñones, M.L.; Suarez, M.; Olano, V.; Murcia, L.M.; Correa, E.; Arévalo, C.; Pérez, L.; Brochero, H.; Morales, A. Presencia de Aedes albopictus en Leticia, Amazonas, Colombia. Biomédica 1998, 18, 192–198.
23. Rossi, G.C.; Pascual, N.T.; Krsticevic, F.J. First record of Aedes albopictus (Skuse) from Argentina. J. Am. Mosq. Control Assoc. News 1999, 15, 422.
24. Kaplan, L.; Kendell, D.; Robertson, D.; Livdahl, T.; Khatchikian, C. Aedes aegypti and Aedes albopictus in Bermuda: Extinction, invasion, invasion and extinction. Biol. Invasions 2010, 12, 3277–3288.
25. Futami, K.; Valderrama, A.; Baldi, M.; Minakawa, N.; Marin Rodriguez, R.; Chaves, L.F. New and common haplotypes shape genetic diversity in Asian tiger mosquito populations from Costa Rica and Panamá. J. Econ. Entomol. 2015, 108, 761–768.
26. Thielman, A.C.; Hunter, F.F. A Photographic Key to Adult Female Mosquito Species of Canada (Diptera: Culicidae). Can. J. Arthropod Identif. 2007, 4, 1–117.
27. Chadee, D.D.; Fat, F.H.; Persad, R.C. First record of Aedes albopictus from Trinidad, West Indies. J. Am. Mosq. Control Assoc. 2003, 19, 438–439.
28. Rossi, G.C.; Martínez, M. Mosquitos (Diptera: Culicidae) del Uruguay. Entomol Vect 2003, 10, 469.
29. Lugo, E.D.C.; Moreno, G.; Zachariah, M.A.; López, M.M.; López, J.D.; Delgado, M.A.; Valle, S.I.; Espinoza, P.M.; Salgado, M.J.; Pérez, R. Identification of Aedes albopictus in urban Nicaragua. J. Am. Mosq. Control Assoc. 2005, 21, 325–327.
30. Marín, R.; del Carmen Marquetti, M.; Álvarez, Y.; Gutiérrez, J.M.; González, R. Especies de mosquitos (Diptera: Culicidae) y sus sitios de cría en la Región Huetar Atlántica, Costa Rica. Rev. Biomédica 2009, 20, 15–23.

31. Navarrro, J.-C.; Zorrilla, A.; Moncada, N. Primer registro de Aedes albopictus (Skuse) en Venezuela: Importancia como vector de Dengue y acciones a desarrollar. Boletín Malariol. y Salud Ambient. 2009, 49, 161–166.
32. Ortega-Morales, A.I.; Mis-Avila, P.; Domínguez-Galera, M.; Canul-Amaro, G.; Esparza-Aguilar, J.; Carlos-Azueta, J.; Badillo-Perry, S.; Marin, P.; Polanco, J.; Fernández-Salas, I. First record of Stegomyia albopicta in Belize. Southwest. Entomol. 2010, 35, 197–198.
33. Marquetti Fernández, M.D.; Jean, Y.S.; Fuster Callaba, C.A.; Somarriba López, L. The first report of Aedes (Stegomyia) albopictus in Haiti. Mem. Inst. Oswaldo Cruz 2012, 107, 279–281.
34. Ali, I.; Mundle, M.; Anzinger, J.J.; Sandiford, S.L. Tiger in the sun: A report of Aedes albopictus in Jamaica. Acta Trop. 2019, 199, 105112.
35. Ponce, P.; Morales, D.; Argoti, A.; Cevallos, V.E. First Report of Aedes (Stegomyia) albopictus (Skuse) (Diptera: Culicidae), the Asian Tiger Mosquito, in Ecuador. J. Med. Entomol. 2018, 55, 248–249.
36. Eritja, R.; Palmer, J.R.B.; Roiz, D.; Sanpera-Calbet, I.; Bartumeus, F. Direct evidence of adult Aedes albopictus dispersal by car. Sci. Rep. 2017, 7, 1–15.