Aedes albopictus as an epidemic vector of chikungunya virus: another emerging problem?

A major epidemic of chikungunya fever on the island of Reunion (population 770,000) has resulted in 265,000 clinical cases (34% of the population) and 237 deaths.1 Surprisingly, Aedes (Stegomyia) aegypti, the mosquito usually implicated in such outbreaks, is virtually absent. Chikungunya is an arbovirus of the family Togaviridae. The natural vectors of the virus are African forest mosquitoes of the subgenera Diceromyia, Stegomyia, and Aedimorphus that feed preferentially on primates.2 The “domestic” form of A aegypti is closely associated with human habitation, readily enters houses, feeds almost exclusively on human beings, and is ubiquitous throughout the tropics. By contrast, Aedes albopictus, the species implicated in the Reunion outbreak, is of Asian origin, is often abundant far from human habitation, and feeds readily on many species of mammals and birds. In the laboratory, many A albopictus strains have a high vector competence (ie, they are readily infected by chikungunya virus),3 but in nature, they are assumed to have a low vectorial capacity (ie, efficacy as a vector) because blood meals taken from non-susceptible hosts do not contribute to the transmission cycle.4

In the Hawaiian islands, major epidemics of dengue were frequent from 1840 until the 1940s, but ceased after an energetic mosquito control campaign. A aegypti was virtually eliminated, but A albopictus remained widespread and abundant.5 Since then, despite a high rate of imported cases, there was no evidence of autochthonous transmission until a small outbreak (122 confirmed cases, 0·01% of the total population) in 2001–02. After nearly 60 years, the human herd immunity was minimal, yet there was no repeat of past epidemics. A aegypti was rare and restricted to one island, but A albopictus was ubiquitous, and super-abundant in the focus of transmission. By contrast, in French Polynesia, where A aegypti remains abundant, there have been ten major outbreaks of dengue since World War II, many with high morbidity and substantial mortality.7 Indeed, there is persuasive evidence that the 2001 outbreak in Hawaii was initiated by infected people arriving from Tahiti, where a major epidemic (about 33,000 cases, 14% of the total population) was under way.

The history of transmission in Hawaii versus Tahiti seems to confirm that A albopictus has a low vectorial capacity for dengue viruses compared with A aegypti, yet in 1977 there was a major outbreak of dengue 2 on Reunion, with an estimated 160,000 cases—ie, 30% of the population8—and laboratory studies confirmed high vector competence in the local A albopictus.9 As in Hawaii, the species was super-abundant, whereas A aegypti had remained rare after an effective control campaign in the 1950s.10,11 Thus, the 1977 epidemic and the current epidemic of chikungunya confirm that A albopictus can have a high vectorial capacity, at least on Reunion. The local A albopictus population may be more anthropophilic than in other parts of the world; a recent study in Thailand found some evidence of a preference for human blood.12 Alternatively, the relative abundance of human beings in the peri-domestic environment could oblige the mosquito to feed on human beings. Other species could conceivably be involved in the transmission cycle. Whatever, the reasons, it is clear that the role of A albopictus as a vector should be reassessed, both on Reunion and in other parts of the world.

Mosquito control is the sole available method for reducing transmission of chikungunya; no vaccines are available. As already mentioned, large-scale campaigns (using DDT) have been highly effective against A aegypti, but not A albopictus. Moreover, in the past three decades, even control of A aegypti has rarely been achieved and never sustained.13 Therefore, if we assume that it is possible to prevent future epidemics, we must explore new and innovative approaches, such as novel methods of using insecticides or the introduction of genetically modified strains.14 It is ironic to reflect that A aegypti, yellow fever, dengue, A albopictus, chikungunya, and West Nile virus all have a common vector: mankind. A aegypti and yellow fever were transported to the New World during the slave trade, A albopictus achieved worldwide distribution via containerised shipments of used tyres,15,16 West Nile virus almost certainly arrived
in the New World in imported birds, and there is a
well-documented global traffic of human viruses in
aircraft passengers. 17 Thus, modern transportation has
produced a quantum leap in the mobility of vectors and
pathogens, and the consequences of this globalisation
will continue to surprise us.

*Paul Reiter, Didier Fontenille, Christophe Paupy*
Institut Pasteur, Insectes et Maladies Infectieuses, Paris, France
(PR); Caracterisation et Controle des Populations de Vecteurs,
UR016, Institut de Recherche pour le Développement,
Montpellier, France (DF, CP)
preiter@pasteur.fr

1 Anon. Cire La Réunion-Mayotte—weekly report. Epidémie de
(accessed June 30, 2006).
2 Diallo M, Thonnon J, Traore-Lamizana M, Fontenille D. Vectors of
Chikungunya virus in Senegal: current data and transmission cycles.
3 Tesh RB, Gubler DJ, Rosen L. Variation among geographic strains of Aedes
albopictus in susceptibility to infection with chikungunya virus.
4 Rodhain F, Rosen L. Mosquito vectors and dengue virus-vector
relationships. In: Gubler DJ, Kuno G, eds. Dengue and dengue
5 Gilbertson WE. Sanitary aspects of the control of the 1943–44 epidemic
7 Murgue B, Deparis X, Chvartac E, Cassar O, Roche C. Dengue: an
evaluation of dengue severity in French Polynesia based on an analysis of
8 Coulanges P, Clercy Y, Jouset FX, Rodhain F, Hamon C. Dengue at
Réunion: isolation of a strain at the Pasteur Institute of Madagascar.
of Aedes albopictus from La Réunion Island (Indian Ocean) with respect to
10 Hamon J. Etudes biologique et systématique des Culicidae de l’île de La
Réunion. Mémoires de l’Institut Scientifique de Madagascar 1953;
4 (Série E): 521–43.
11 Salvan M, Mouchet J. Aedes albopictus and Aedes aegypti at Ile de la
12 Ponlawat A, Harrington LC. Blood feeding patterns of Aedes aegypti and
13 Reiter P, Gubler DJ. Surveillance and control of urban dengue vectors. In:
Gubler DJ, Kuno G, eds. Dengue and dengue hemorrhagic fever:
15 Reiter P, Darsie R. Aedes albopictus in Memphis, Tennessee (USA): an
achievement of modern transportation? Mosquito News 1984; 44:
396–99.
16 Reiter P, Sprenger D. The used tire trade: a mechanism for the worldwide
dispersal of container breeding mosquitoes. J Am Mosq Control Assoc
17 Gubler DJ. Dengue and dengue hemorrhagic fever: its history and
Dengue and dengue hemorrhagic fever. Wallingford, UK: CABI