Aedes albopictus — A New Disease Vector for Europe?

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SUMMARY: *Aedes albopictus* is an important and widespread vector of dengue in many tropical countries. Its eggs and larvae are readily transported in commodities, such as old vehicle tyres, to many temperate regions, where it is able to survive and breed. It could thus become a serious health threat in Europe.

Introduction

Aedes albopictus, the Asian Tiger Mosquito, is an aggressive, mobile and very plastic Culicinae mosquito.

Aedes albopictus occurs throughout the Oriental region, southeast to New Guinea and on most islands in the Indian Ocean westward to (and including) Madagascar. In China, *Ae. albopictus* occurs as far north as Beijing (39.55°N), in Korea as far north as Seoul (37.30°N), and in Japan as far north as Sendai (38.16°N) (1).

Over the last few decades the range of *Ae. albopictus* has expanded, locally due to its ability to colonise man-made containers, and globally due to colonisation of used car tyres which have been exported from Asia to various parts of the world. Since its discovery in the United States in 1985 (2) *Ae. albopictus* has colonised at least seventeen States in the U.S. and can now be found in Brazil (3), Australia (4), Nigeria (5), South Africa (6), Hawaii, and the islands of the South Pacific (1).

Medical importance

Aedes albopictus is a known vector of the four strains of dengue virus in southeast Asia, the Seychelles, southern China and Japan. The mosquito can become infected transovarially as well as by feeding on an infected host (1). *Ae. albopictus* is often regarded as a minor vector of dengue because of the greater importance of *Ae. aegypti*, with the latter usually only transmitting the more severe strains of the dengue virus and the former being able to transmit the full range of strains of dengue virus (1).

Ae. albopictus could undoubtedly become a significant vector of dengue in North and South America (1) and Australia (4). In Asia the mosquito lives in forest fringes and so can transport new arbovirus strains from the forest into local communities. The same may occur in America.

Ae. albopictus has been found to be an efficient transmitter of at least 26 human diseases (7) including, dengue, LaCrosse virus, Chikungunya virus, Japanese

encephalitis, St. Louis encephalitis, Western equine encephalomyelitis, Orungo virus, Ross River virus and Yellow fever (8).

Habitat

Aedes albopictus occurs in urban areas with vegetation and breeding sites, suburban, rural and forest habitats (near the forest fringe but rarely deep in the forest) (1). Larvae may be found in a wide range of containers, both natural and man-made, from tin cans to gallon drums, and in tree holes, bamboo stumps, pools and leaf axils (1). In its adopted countries *Ae. albopictus* occurs mainly in used tyres in which water can accumulate, but it has also been found in tree holes.

Biology

Aedes albopictus egg mortality in nature is due to desiccation, predation and cold, depending on the strain of mosquito. Older eggs can survive desiccation better than newly laid eggs; temperate strains survive cold better than tropical strains. A low oxygen concentration has been found to be an important stimulus for egg hatching and several floodings may also be required (1). Eggs of temperate strains of *Ae. albopictus* can go into diapause, the embryos resting until warmer weather triggers further development (9). Diapause, in temperate strains, is controlled by a photoperiodic response in adult female mosquitoes — long days cause non-diapausing eggs to be laid and short days stimulate diapausing eggs (1).

High larval density and low food supply lead to high larval mortality and small adult size (due either to less food per larva or chemical inhibitors produced by larvae at high densities. Predators can be an important limitation to larval *Ae. albopictus* survival, (for example, *Toxorhynchites* larvae, a carnivorous mosquito, eats other larval mosquitoes). There are also parasites, such as the fungus *Coelomomyces stegomyiae* and the ciliate *Lambornella stegomyia*, which increase larval mortality (1).

Adult *Ae. albopictus* rest near the ground and bite

aggressively, attacking any exposed skin, particularly around the ankles and knees, with peaks of biting activity in the early morning and late afternoon (1). An average biting rate of 14 bites per man-hour (in Madagascar, between 16:30 and 18:30 hours) has been recorded (10). The mosquito is usually outdoor-biting and rarely bites at night. It seldom flies in windy conditions and hence wind-aided dispersal is unlikely to occur in this species (1).

Ae. albopictus is well adapted to breeding in ephemeral water pools (for example, larvae have been found in the finger holes of a bowling ball left in the rain in Chicago), the female ovipositing in a number of containers, thus increasing the chances of offspring survival (2). The female prefers to lay her eggs above the water surface on a dark, rough and vertical substrate (1). In tyres, the eggs are laid on the inner surface; when rain fills the tyre the eggs hatch and the larvae begin to develop (2).

The potential spread of *Ae. albopictus*

Nawrocki and Hawley (11) estimated the potential northern range of *Aedes albopictus* in North America based on reports of the north Asian distribution and climatological data for Asia and America. The northern range was divided into two types — the overwintering limit and the late summer expansion range. *Ae. albopictus* has been found as far north as Beijing (39.55°N) in China, although it probably does not overwinter there. Successful overwintering of *Ae. albopictus* has been documented in Tsinan (36.41°N) in

China (mean January temperature = -1.2°C), Ashikaga (36.21°N) in Japan (mean January temperature = $+2.4^{\circ}\text{C}$), and Kumsa (36°N) in S. Korea (mean January temperature = -3°C). Based on these data, if the January 0°C isotherm is the limit of the overwintering range for *Ae. albopictus* then the mosquito may have already reached its limit, in Illinois; however if the January -5°C isotherm is used as the limit of the overwintering range then *Ae. albopictus* could spread to the southern edge of Canada (11). Although abundant rainfall is not essential for *Ae. albopictus* establishment, low summer rainfall could limit its spread northwards. Conversely the probability of *Ae. albopictus* becoming established along the Pacific coast may be higher in wetter, more northern districts (11).

Based on these estimates (i.e. *Ae. albopictus* covers areas where the mean January temperature is greater than 0°C and where there is sufficient summer rainfall), *Ae. albopictus* may be able to spread throughout Europe, including the U.K. (Fig 1), and the discovery of this species in Geneva may be the beginning of this invasion.

Conclusion

Aedes albopictus "is an ecological generalist capable of rapid evolution and, with the aid of man, speedy colonization of new habitats" (1). This mosquito has now spread into the western hemisphere due to the shipment of used tyres from Asia. Cargo imported into Africa is not routinely inspected for mosquitoes and therefore, other, as yet undetected, populations of *Ae. albopictus*

Fig 1. Mean January (northern hemisphere) and July (southern hemisphere) 0°C isotherms. Most of Europe actually falls within the habitat range of *Ae. albopictus* (temperate strains) as described by Nawrocki and Hawley (1987). (Figure from Bartholomew (12).)

may already exist in Africa (7). From there, the mosquito could spread into Europe where suitable habitats and an available niche for *Ae. albopictus* to become established, undoubtedly occur.

Dengue fever is known to have occurred in Europe, with a large outbreak in Greece in 1927-1928 affecting over one million people (13). The disease was probably introduced from Africa via migrating birds.

Thus if *Ae. albopictus* were to become established in Europe, dengue could become a serious European health problem and just one of a series of arboviral diseases (to which few Europeans are immune) which may be transported with *Ae. albopictus*, in used tyres.

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