THE SIGNIFICANCE OF THE INTRODUCTION OF *AEDES ALBOPICTUS* INTO THE SOUTHEASTERN UNITED STATES WITH IMPLICATIONS FOR THE CARIBBEAN, AND PERSPECTIVES OF THE PAN AMERICAN HEALTH ORGANIZATION[1]

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ABSTRACT. The introduction and apparent infestation of *Aedes albopictus* into the Gulf States of Texas and Louisiana in the United States is viewed as the most singular medical entomological happening of this decade in the Americas. The implications for the Caribbean and other countries southward are serious, as the habitat described for this *Stegomyia* cousin of *Ae. aegypti* , is amply available in the Windward and Leeward islands of the Antilles. Studies from the Pacific and regions of Southeast Asia indicate that *Ae. albopictus* competes for the same peridomestic niches as *Ae. aegypti* and it has been found to be a competent vector of several dengue serotypes. In this presentation, a call is issued to the mosquito control and abatement programs in the Gulf States to take stringent measures to eliminate this new dengue vector before it becomes thoroughly established and spreads to other states as well as into countries of the Americas and into the West Indies.

INTRODUCTION

At present we find ourselves occupied with a serious concern regarding the recent introduction of *Aedes albopictus* (Skuse) into the Gulf States and whether this second vector of dengue will eventually spread and carry disease into the islands of the Caribbean and the Americas southward. The introduction of a medically important mosquito species into an extensive peridomestic niche, which for all practical purposes is only partially occupied by *Ae. aegypti* (Linn.) in the Caribbean and other countries of the tropical Americas, is the basis for this grave concern.

The World Health Organization (1985) reported that during the period from 1970 to 1980, airline passenger volume increased tenfold in some countries of the world and sea transport expanded as well. Will global transport be the means for the spread of this vector species into other countries in the Americas? We could speculate that it may be just a matter of time before *Ae. albopictus* will be discovered in Florida, and from there be distributed to other states, and into the West Indies.

Recently while in the Miami International Airport (November 1985), the author collected an adult, female, *Ae. aegypti* while browsing at a newstand. It would be suitable to recall, as reported by Hammon (1969), that dengue fever epidemics have occurred sporadically in Florida, the last being reported in 1936, apparently being dengue type 2 (D-2), as well as the more recent D-1 outbreak, which occurred in Texas in 1980 [Morbidity and Mortality Weekly Report (MMWR) 1980], which represented the first indigenous case of dengue in the United States since 1945.

With the introduced cases of dengue in the United States from Africa, South America, the Caribbean, Southeast Asia, and elsewhere, as reported by Center for Disease Control (MMWR 1983, 1985) which number perhaps in the 1,000's since the late 1970s, how long will it take to see *Ae. albopictus* involved in a dengue outbreak in the Gulf States?

Could *Ae. albopictus* be introduced into the Caribbean first through Puerto Rico, which is the major ship cargo transfer port in the Antilles, and then find its way into another large island, like Jamaica and Trinidad and Tobago, with heavy ocean traffic? Or will *Ae. albopictus* be borne by one of the numerous airlines which frequent the West Indies and infest Antigua, Barbados, or one of the Netherland Antilles isles, which are also popular ports of call for tourists from around the world? We should not overlook the American and British Virgin Islands, and those multiple family islands of the Bahamas, where a profusion of small craft plying the seas, sail into those exotic ports, carrying large stores of fresh water, which could provide resting or breeding habitat for *Stegomyia* vectors.

DEVELOPMENT

With respect to such speculation and potentially rapid expansion of this new vector species, we have the following true account. Epidemics of dengue began occurring on Pacific islands where there had been an

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absence of the virus for 25 years or more. The cause of the introduction of new dengue serotypes into that part of the world was at first thought to be related to the entry of viremic passengers rather than by infective mosquitoes. However, during this same common period of heavy travel and dengue outbreaks, there came reports of the introduction of *Ae. aegypti* in 1978 into the Tokelau islands and of *Ae. albopictus* being found in that same year in the Solomon Islands.

The introduction of this new vector species into the Solomons had serious public health implications later, as a dengue outbreak occurred in 1982 with *Ae. albopictus* as the vector. The new vector has continued to spread its range to at least Truk Island in Micronesia (World Health Organization, 1985).

In the Caribbean, Chadee (1984) reported on a 10-year surveillance (1972–82) by Insect Vector Control inspectors of 46,895 boats at the Port-of-Spain harbor, Trinidad of which 31 had *Ae. aegypti* breeding in various containers on board, including drums, plastic buckets, water tanks, life boats and tubs. The boats were primarily from South America or the Caribbean region.

In another study reported by Le Maitre and Chadee (1983) insects were collected at Piarco International Airport, Trinidad, during the period 1965–74, from aircraft belonging to 10 airlines, as well as from a number of private airplanes. A total of 89,863 aircraft were inspected and 592 planes belonging to nine airlines were found to be carrying arthropods.

Although 83% of the insects collected were house flies, mosquitoes constituted 5.3%, including *Ae. taeniorhynchus* (Wied.), *Ae. aegypti*, *Ae.* spp., *Anopheles albimanus* Wied, *An. aquasalis* Curry, *Culex quinquefasciatus* Say and other *Culex* spp.

The interception of *An. albimanus* represented the potential introduction of a new and important malaria vector into Trinidad. The mosquitoes in general were captured from flights originating in Brazil, Guadeloupe, Puerto Rico, Venezuela, Grenada, Barbados, Suriname, and Colombia.

How important is this news regarding the infestation of *Ae. albopictus* in the Gulf States of the USA? When Reiter and Darsie (1984) reported on the collection of one female *Ae. albopictus* using a CDC Gravid Mosquito Trap near the center of Memphis, Tennessee, most entomologists familiar with the finding shrugged it off as being an isolated, dead-end introduction, much like that of Bell and Benach's report (1973) of the collection of *Ae. aegypti* in southeastern New York State. However, this first report was to be followed by the serious revelation of now extensive *Ae. albopictus* infestation in parts of Texas and Louisiana.

VECTOR COMPETENCE OF *AEDES ALBOPICTUS*

As early as 1930, Simmons et al. (1931) in Manila, reported the experimental transmission of dengue virus by *Ae. albopictus* in man-to-man transmission among seven volunteers, all of whom became ill. They concluded that *Ae. albopictus* was as important in the transmission of dengue as was *Ae. aegypti*.

Chan et al. (1976) noted that *Aedes albopictus* was common both in rural and urban areas of Singapore in the 1960s; subsequently dengue type 2 virus was isolated from this species (Rudnick and Chan 1965). He recommended that further study was needed to determine its significance in relationship to dengue hemorrhagic fever.

During the period 1966–68, a dengue hemorrhagic fever epidemic struck Singapore, and dengue type 1 (D-1) and D-2 viruses were recovered from pools of *Ae. albopictus*. Those isolations, in addition to D-2 made from pools of *Ae. aegypti*, were obtained from four different areas of the city. The pattern of the epidemic curve followed the seasonal fluctuations of both mosquito species.

From the study by Chan et al. (1971b), dengue virus infection rates per 1000 mosquitoes were estimated to be 0.51 for *Ae. aegypti* and 0.59 for *Ae. albopictus*. During the outbreak, the house index reported for *Ae. aegypti* ranged from 14.8 to 29.6%, and from 2.5 to 15.9% for *Ae. albopictus*.

In some areas of Singapore, the house-associated populations of *Ae. albopictus* represented only a fraction of the entire population in the survey area. In areas with vacant lots, open fields, and parks, breeding of *Ae. albopictus* was found in high density in such foci as tire dumps, tin cans and other such discarded containers.

Another question related to the Americas is whether *Ae. albopictus* is an efficient vector of yellow fever (YF) virus, as well as of dengue, thus bridging the gap between the sylvatic habitat now occupied by *Haemogogus* spp. and the urban environment occupied by *Ae. aegypti*.

The literature is replete with the answer as it pertains to dengue. In some instances, it is more competent than *Ae. aegypti*. Rosen et al. (1983) compared the rates of transovarial transmission (TOT) between *Ae. aegypti* and *Ae. albopictus* using all four dengue serotypes and surprisingly found the highest rates were obtained by *Ae. albopictus*. Their findings support the view that while *Ae. aegypti* is of

major importance from the standpoint of transmission of dengue to man, it may be relatively unimportant in the overall natural history of dengue virus.

SUITABLE HABITAT

Does there exist in the natural salubrious environment of the Caribbean, including the Greater and Lesser Antilles, suitable niches to sustain *Ae. albopictus*? The obvious answer is a forthright affirmative. The breeding habitat occupied by *Ae. aegypti* is very similar to that required by its *Stegomyia* cousin, *albopictus*.

The type of habitat which is required by *Ae. albopictus* typically exists in suburban and rural areas, which are marginally utilized in the West Indies by *Ae. aegypti* and on some of the Windward islands, shared by *Ae. mediovittatus* (Coq.). In the Caribbean, the predominance of human dwellings, either in the city, or in suburban areas, are surrounded by lush tropical vegetation, including many types of fruit and shade trees, banana and plantain, as well as bromeliads attached to tree boughs. Such habitat, often bearing rubbish and trash hidden in tall grass, is ideally suited to *Ae. albopictus*, and only incidentally utilized by *Ae. aegypti*.

Specifically, *Ae. albopictus* prefers natural habitats such as tree cavities, leaf axils, and artificial containers like tin cans, tires, etc. (Chan 1985[3]). In 1973, during a sylvatic dengue study in a Malaysia primary rain forest (Knudsen 1977) while searching for the forest vector of dengue, we observed that *Ae. albopictus* penetrated the forest proper from a neighboring oil palm estate, a distance of only a few hundred meters.

Rozeboom and Bridges (1972) reported that after *Ae. albopictus* was introduced onto Guam in 1944, the natural population of *Ae. guamensis* Furner and Bohart decreased by as much as 95% in artificial containers and by 30% or more in natural breeding habitat, as the apparent result of competition from *Ae. albopictus*.

In Singapore, where it was originally believed to be a sylvan or feral breeder in forest fringes, *Ae. albopictus* has now become well established in the domestic environment of that highly urbanized city, following the niche requirements of *Ae. aegypti*. Chan (1971a, 1971b) explained that both vectors are container breeders, with about 95% of the preferred habitat being domestic containers such as jars, ant traps, bowls, tanks, tin cans, tires and drums. Thus, these two species, as suggested by others, are ecologically compatible and do coexist in similar foci in many countries.

Are these Pacific habitat descriptions different from those reported in the Caribbean? No, in fact they are carbon copies of the Caribbean data which were obtained for *Ae. aegypti*. This principal dengue vector was found breeding, 93% of the time in drums, flower vases, pails, tires, cisterns, tins and jars, abandoned appliances and animal watering pans. (Knudsen 1983, Knudsen, unpublished data).

SURVEILLANCE

We have, therefore, a tailor-made situation awaiting the arrival of *Ae. albopictus*, with a habitat already provided by man, awaiting dual occupancy in the Caribbean and elsewhere.

One major concern which must be voiced, is that early detection of either *Ae. albopictus* adult mosquitoes or immatures in the islands of the West Indies and elsewhere in the Americas to the south must be a priority. Most of the insect vector control or *Aedes aegypti* eradication programs in the West Indies, employ no professional entomologists. The efforts are principally led by Public Health Inspectors who have inadequate training and taxonomic capabilities needed to recognize this new species. In most cases, the vector control programs do not have even a simple dissecting microscope with which to work, and often the examination of egg paddles is done by means of a hand lens alone.

It is possible that *Ae. albopictus* could already have been introduced into the Caribbean, and that its detection awaits discovery by a professional entomologist with taxonomic interests. These capabilities at present lie basically with just a handful of programs at the San Juan Center for Disease Control laboratory or the Caribbean Epidemiological Research Center (CAREC) in Trinidad.

CONCLUSIONS

In conclusion, the Pan American Health Organization/World Health Organization views the introduction of *Ae. albopictus* into the Gulf States as one of the most significant entomological/epidemiological happenings in this decade. The presence of this Asian *Stegomyia* into the Gulf States is considered to

[3] Chan, K. L. 1985. Singapore's dengue haemorrhagic fever control programme: a case study of the successful control of *Aedes aegypti* and *Aedes albopictus* using mainly environmental measures as part of intergrated vector control. Unpublished manuscript, World Health Organization Expert Committee on Vector Biology and Control. 103 pp.

be dangerous due to the potential significance of *Ae. albopictus* as a vector of dengue, with the accompanying risk of its possible involvement in disease transmission of other arboviruses.

The subject of this presentation puts the countries of the Caribbean, Central and South America into a new perspective, that being the burden of now conducting surveillance to discern whether *Ae. albopictus* has been introduced, with the continuing and unabating problem of battling an already very efficient vector, and old enemy, *Ae. aegypti*.

Therefore, a call is issued to mosquito control and abatement programs in the Gulf States, to take the necessary stringent measures to eliminate this new dengue vector before it becomes thoroughly established and spreads to the tropical areas southward. In addition, it is strongly suggested that the countries of the Americas re-examine the concept of eradication at present only partially aimed at *Ae. aegypti* and seriously consider applying it to *Ae. albopictus* as well, as the presence of this new dengue vector potentially threatens the health and well being of millions of people.

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