VECTOR COMPETENCE OF *AEDES ALBOPICTUS* FROM HOUSTON, TEXAS, FOR DENGUE SEROTYPES 1 TO 4, YELLOW FEVER AND ROSS RIVER VIRUSES

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ABSTRACT. A combination of virus infection and transmission experiments showed that a Houston, Texas strain of *Aedes albopictus* is a competent vector for dengue (DEN), yellow fever (YF) and Ross River (RR) viruses. However, at 14 days incubation, DEN virus infection rates in a Puerto Rican strain of *Aedes aegypti* were significantly higher for each of the four DEN serotypes, except DEN-1, than in Houston *Ae. albopictus* fed simultaneously on the same virus suspensions. The degree of correlation between disseminated DEN infection rates in Houston *Ae. albopictus* and transmission to an *in vitro* system ranged from 42 to 88% for the four DEN serotypes. No significant difference was noted in YF virus infection rates or transmission rates in the two mosquito species fed on the same virus suspensions and incubated for the same time period. Also, RR virus infection and transmission rates in Houston and Hawaiian strains of *Ae. albopictus* were generally comparable.

INTRODUCTION

Since the discovery of *Aedes albopictus* (Skuse) in Harris County, Texas (Sprenger and Wuithiranyagool 1986), its presence has been documented in 12 states in the United States and in three states in Brazil (Anonymous 1986a, 1986b; Forattini 1986; CDC, unpublished data). Aside from its significance as a pest species, *Ae. albopictus* in the Western Hemisphere has aroused the interest of public health authorities because of its known and potential vector relationship with several arboviruses of public health importance (Shroyer 1986). Of chief concern in the southern United States, and Central and South America is the impact that *Ae. albopictus* may have on the transmission and maintenance of dengue (DEN) and yellow fever (YF) viruses. We report here on experimental infection and transmission studies with these viruses and a strain of *Ae. albopictus* from Houston, Texas. In addition, we have included Ross River (RR) virus, an alphavirus that has recently extended its range into the Pacific basin and for which several geographic strains of *Ae. albopictus* have been shown to be efficient experimental vectors (Mitchell and Gubler 1987).

MATERIALS AND METHODS

Viral and mosquito strains. The sources and passage histories of the viral strains are shown in Table 1. The Houston *Ae. albopictus* colony was established from 48 females collected as adults and approximately 12 females and a few males reared from larvae, all collected in Houston, Harris County, Texas, during March 1986. Only F_2 and F_3 laboratory generation females were used in our experiments. The Hawaii *Ae. albopictus* colony used for comparative purposes in the RR virus experiments was from Makiki, Oahu, Hawaii, and in the F_{19} and F_{20} laboratory generations; its vector competence for RR virus had been determined previously (Mitchell and Gubler 1987). The *Ae. aegypti* (Linn.) strain was from the Rexville, Puerto Rico colony maintained at the Centers for Disease Control (CDC) laboratory in San Juan. The generation history of the parent colony is unknown, but the strain had been colonized for about 4 years with periodic additions of field-collected *Ae. aegypti*. A subcolony was established in our Fort Collins insectary during March 1986, and F_1, F_2 and F_3 generations from this colony were used in the experiments.

Experimental procedure. All mosquitoes were reared at 26.7 (±0.5°C), 80% RH, and a photoperiod of L:D 16:8. Three- to five-day-old females were used in the feeding trials. Mosquitoes were allowed to feed on suspensions consisting of fresh DEN virus grown in *Toxorhynchites amboinesis* (Doleschall) or YF virus grown in C6/36 cells or suckling-mouse brains, harvested on the day of feeding, diluted as appropriate, and mixed with equal volumes of washed human red blood cells. Procedures for preparing and feeding the YF virus suspension were described in detail (Miller and Mitchell 1986); the following procedure for preparing the DEN virus is that used at the CDC, San Juan Laboratories. Recently emerged *Tx. amboinesis* females were inoculated with seed virus, incubated for 7 days at 26.7°C, and cold-anesthetized mosquitoes were triturated live in heat-inactivated calf serum at ratios of 0.1 to 0.2 ml per mosquito, depending on the number of mosquitos available and the volume of feeding suspension required.

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Table 1. Sources and passage histories of viral strains.

Virus	Strain	Source	Location	Year	Passage
DEN-1	1620	Human serum	Puerto Rico	1985	Mosquito-1
DEN-2	1615	Human serum	Puerto Rico	1985	Mosquito-1
DEN-3	1557	Human serum	Mozambique	1985	Mosq.-1, C6/36-1
DEN-4	1632	Human serum	Puerto Rico	1985	Mosquito-1
YF	788379	*Haemagogus spegazzini*	Trinidad	1978	C6/36-2
RR		Human serum	Rarotonga	1980	Mosquito-1

Mosquito suspensions were centrifuged at 4,000 rpm for 30 min at 4°C, and the supernatant was removed, diluted as appropriate, and mixed with equal volumes of washed red blood cells. Generally, suspensions containing freshly harvested DEN or YF viruses were fed undiluted and at 10- and 100-fold dilutions. The feeding suspensions were warmed for 4 min at 37°C, and drops were placed directly on nylon netting covering pint-sized cages containing the mosquitoes. Mosquitoes were exposed for 15 min, and fully engorged specimens were sorted, placed in cages, given 5% sugar water, and incubated for appropriate intervals at 26.7°C and 80% RH. Mosquitoes ingested RR virus by feeding on viremic hamsters infected by subcutaneous inoculation 48 to 96 hr prior to feeding (Mitchell and Gubler 1987).

Yellow fever and RR virus transmission trials were conducted by allowing mosquitoes to feed on 2-day-old suckling mice. Mice were monitored for 14 days for signs of illness or death. Dengue virus transmission was determined by the *in vitro* feeding technique described by Aitken (1977). Capillary tubes were loaded with approximately 5 μl of calf serum, and the proboscis of a test mosquito was inserted in a tube following removal of the mosquito's wings. The capillary tube was fixed in a Styrofoam® rack, and each mosquito was left in place for at least 30 min. The amount of feeding suspension ingested was recorded, and the remainder of the suspension was expressed onto a microscope slide, loaded into a calibrated capillary needle, and injected parenterally into five, or occasionally fewer, Rexville *Ae. aegypti*. These mosquitoes were given 5% sugar water and incubated at 26.7°C for 7 days. They were frozen at −70°C until assayed for virus.

Mosquito infection with DEN and YF viruses was determined by examining head squashes for viral antigen by the direct fluorescent antibody test (DFAT) (Kuberski and Rosen 1977). Sometimes associated carcasses were sonicated and tested for YF virus by plaque assay in Vero cell culture. All assays for RR virus in mosquitoes were done in Vero cell culture by methods recently described (Mitchell and Gubler 1987).

Dengue stock virus and feeding suspensions were titrated by inoculating *Tx. ambionensis* with 0.17 μl each of tenfold dilutions (Rosen and Gubler 1974) and calculating the mosquito infectious dose$_{50}$ (MID$_{50}$)/ml (Reed and Muench 1938). Titrations of YF virus (Miller and Mitchell 1986) and RR virus (Mitchell and Gubler 1987) were done by plaque assay in Vero cell culture.

RESULTS

The susceptibility of Houston *Ae. albopictus* to *per os* infection with DEN viruses 1–4 is compared with that of Rexville *Ae. aegypti* in Table 2. Generally, DEN viral antigen was detectable in head tissues by day 7 of incubation in both species; however, *Ae. albopictus* did not have detectable DEN-2 antigen at that time. *Aedes aegypti* was not tested for DEN-4 antigen on day 7 because unexplained mortality in this cohort reduced the sample size, and we wished to keep the remainder for a longer incubation period.

Disseminated DEN virus infection rates were compared in both species for each DEN serotype. There was no significant difference in infection rates for any DEN serotype in *Ae. aegypti* and *Ae. albopictus* incubated less than 14 days. However, at 14 days' incubation, the infection rates in *Ae. aegypti* were significantly greater ($P \leq 0.05$, Fisher's exact test) for each DEN serotype except DEN-1.

Titers of DEN virus feeding suspensions that would be expected to result in 50% infection rates in *Ae. aegypti* and *Ae. albopictus* that fed on these suspensions were calculated from the data in Table 2 for DEN-1, DEN-2 and DEN-3, i.e., $\log_{10}$ MID$_{50}$/ml. DEN-4 was not included because of the paucity of data points. These titers were virtually identical for DEN-1, 7.19 and 7.20 in *Ae. aegypti* and *Ae. albopictus*, respectively. However, the titer of the DEN-2 feeding suspension required to infect 50% of *Ae. aegypti per os* (6.57) was significantly lower ($P \leq 0.05$, probit analysis) than for *Ae. albopictus* (7.67). A significant difference ($P \leq 0.05$) also was noted for DEN-3 virus, where the titers required to infect 50% of *Ae. aegypti* and *Ae. albopictus* were 7.20 and 9.16, respectively.

We also tested four groups of *Ae. albopictus* for their ability to transmit each of the four

Table 2. Susceptibility of Rexville *Aedes aegypti* and Houston *Aedes albopictus* to infection *per os* with dengue viruses.

Dengue virus	Days incubation	Titer[a] feeding suspension	Infection rates[b] *Ae aegypti* No. tested	*Ae aegypti* % pos.	*Ae. albopictus* No. tested	*Ae. albopictus* % pos.
1	7	9.0	20	45	20	60
		9.2	0		19	58
	14	6.6	60	38	60	23
		7.6	58	67	60	70
		8.9	0		25	100
		9.0	57	75	68	85
		9.2	21	100	40	98
2	7	7.6	20	25	0	
		7.6	0		20	0
	13	6.3	31	10	60	12
		7.4	11	36	54	26
		9.0	5	40	37	23
	14	5.6	33	24	34	3
		6.6	14	7	35	17
		7.6	27	74	32	53
		7.6	20	85	38	45
		8.4	25	92	23	74
3	7	8.3	20	10	0	
		8.4	0		20	15
	14	6.3	32	41	60	27
		7.4	60	68[c]	59	22
		8.1	25	64	15	53
		8.3	60	47[c]	53	38
		8.4	7	71	34	41
4	7	8.0	0		20	0
		9.2	0		20	5
	13	6.2	13	0	60	7
		7.4	14	14	60	13
		8.0	11	45	59	39
	14	7.9	25	76	19	43
		9.2	6	50	42	29

[a] $\log_{10}$ MID_{50}/ml.
[b] Based on detection of DEN viral antigen in head tissues by DFAT.
[c] Records for the numbers fed and tested from these groups suggest that a labelling error occurred; therefore, these data probably should be reversed.

DEN viruses following exposure to infection *per os* and 14 days of incubation. Correlation between disseminated infection rates, i.e., mosquitoes with positive head squashes, and virus transmission rates ranged from 42 to 88% (Table 3).

Yellow fever virus infection and transmission rates in *Ae. aegypti* and *Ae. albopictus* are compared in Table 4. Both species had comparable infection (70 and 80%) and transmission (46 and 55%) rates 11 days after feeding on a meal containing $10^{6.7}$ MID_{50}/ml of YF virus. No significant differences ($P > 0.05$, Fisher's exact test) were noted in the infection rates or transmission rates of the two species following ingestion of similar amounts of virus and incubation for the same time period.

In addition to the data on YF summarized in Table 4, data were obtained on infection thresholds and virus dissemination rates in *Ae. aegypti* and *Ae. albopictus* fed simultaneously on a meal containing $10^{4.9}$ MID_{50}/ml of YF virus. On day 11 of incubation, 4 of 25 (16%) *Ae. aegypti* bodies contained virus as compared to 1 of 25 (4%) *Ae.*

Table 3. Day-14 infection and transmission rates in the Houston strain of *Aedes albopictus* orally exposed to the four serotypes of dengue virus.

Dengue serotype	Meal titer $\log_{10}$ MID_{50}/ml	No. infected[a]/ no. tested	No. transmitting[b]/ no. infected
1	8.9	25/25 (100%)	21/24 (88%)
2	8.4	23/25 (92%)	17/23 (74%)
3	8.1	16/25 (64%)	8/15 (53%)
4	7.9	19/25 (76%)	8/19 (42%)

[a] Based on detection of dengue viral antigen in mosquito head tissues by DFAT.
[b] Determined by the *in vitro* feeding technique of Aitken (1977).

Table 4. Infection and transmission rates in *Aedes aegypti* and *Aedes albopictus* fed simultaneously on yellow fever virus suspensions.

Meal titer $\log_{10}$ PFU/ml	Extrinsic incubation	No. infected[a]/no. tested		No. transmitting[b]/no. infected	
		Ae. aegypti	*Ae. albopictus*	*Ae. aegypti*	*Ae. albopictus*
6.7	11 days	20/25 (80%)	21/30 (70%)	6/13 (46%)	6/11 (55%)
6.7	14 days	1/1 (100%)	34/46 (74%)	0/1	4/28 (14%)
5.9	11 days	10/24 (42%)	19/30 (63%)	3/8 (38%)	1/14 (7%)
5.9	14 days	3/3 (100%)	13/20 (65%)	1/3 (33%)	1/8 (13%)
5.0	14 days	12/30 (40%)	6/20 (30%)	3/7 (43%)	0/6

[a] Based on detection of yellow fever viral antigen in mosquito head tissues by DFAT.
[b] Yellow fever virus transmission was assayed by allowing mosquitoes to feed on 2-day-old mice.

albopictus. Yellow fever viral antigen was detected in 1 of 25 *Ae. aegypti* heads and none of 25 *Ae. albopictus* heads. On day 14 of incubation, 4 of 10 (40%) *Ae. aegypti* and 8 of 55 (15%) *Ae. albopictus* bodies contained YF virus, and 1 of 10 (10%) and 1 of 55 (2%) heads were positive for antigen. The observed differences in infection and dissemination rates between the two species are not significant ($P > 0.5$). All mosquitoes were given an opportunity to refeed on suckling mice to test for virus transmission; however, since infection rates were low, there were few mosquitoes with disseminated infections among those that refed. The single infected *Ae. aegypti* that refed on day 11 successfully transmitted virus; none of the remaining *Ae. aegypti* and *Ae. albopictus* that refed had disseminated infections. On day 14, the single *Ae. aegypti* with a disseminated infection did not refeed; the single *Ae. albopictus* with a disseminated infection refed but did not transmit virus.

Ross River virus infection and transmission rates in Houston and Hawaii *Ae. albopictus* are compared in Tables 5 and 6, respectively. Both strains were susceptible to infection *per os*, although the Hawaii strain was significantly ($P \leq 0.05$) more susceptible than the Houston strain in one feeding trial in which the hamster was circulating $10^{5.2}$ Vero cell plaque-forming units (PFU)/ml in the blood at the time of feeding. Both species could transmit virus on day 7 of incubation, but transmission rates were higher on day 14 (Table 6). In two instances, RR virus transmission rates were significantly higher ($P \leq 0.05$) among Hawaii *Ae. albopictus* than among the Houston strain.

DISCUSSION

Geographic strains of *Ae. albopictus* are known to vary in their ability to become infected with dengue viruses by the oral route (Gubler and Rosen 1976). Our results show that the Houston strain of *Ae. albopictus* is susceptible to infection by each DEN virus by the oral route and that a high proportion of infected mosquitoes can transmit these viruses by 14 days postinfection (Tables 2 and 3). Some *Ae. albopictus* had disseminated infections of DEN-1, DEN-3 and DEN-4 by day 7 postinfection, thus suggesting that a portion of the mosquitoes may be able to transmit virus at this time. The Houston strain of *Ae. albopictus* was significantly less susceptible to *per os* infection with DEN-2, DEN-3 and DEN-4 viruses than was *Ae. aegypti*, but susceptibilities to DEN-1 virus were comparable. The relative susceptibility of the two species can be expected to vary depending on the origin of the geographic strains (Gubler and Rosen 1976, Gubler et al. 1979).

The DEN viruses also varied in their infectivity. In general, DEN-1 and DEN-2 viruses were most infectious, DEN-3 intermediate, and DEN-4 the least infectious. Such variation in the infectivity of DEN viruses has been observed previously (Gubler and Rosen 1976). Transmission rates of the four DEN viruses also were different (Table 3); however, this variation may be due to either viral strain variation or the titer of the infective meal. Experiments were not done to answer this question.

The DEN virus infection rates reported here are generally higher than those found by Gubler and Rosen (1976). The titers of our feeding suspensions were sometimes higher, and the use of fresh virus suspensions that had not been frozen (Miller and Gubler, unpublished data) probably accounts for the observed differences. Several investigators have shown that infection rates for a variety of arboviruses generally are lower in mosquitoes fed virus suspensions when compared with mosquitoes fed directly on viremic hosts with comparable titers (Mitchell 1983). Therefore, data presented here concerning thresholds of infection for DEN and YF viruses cannot be extrapolated and applied directly to field situations. It follows that we cannot draw any firm conclusions about the susceptibility thresholds of *Ae. albopictus* to infection with DEN and YF viruses in relation to virus titers that might be encountered when feeding on viremic humans. Nonetheless, the compari-

Table 5. Ross River virus infection rates in Hawaiian and Houston strains of *Aedes albopictus*.

Titer[a] of infective meal	Day-7 incubation		Day-14 incubation	
	Hawaii	Houston	Hawaii	Houston
	n (% infect.)	n (% infect.)	n (% infect.)	n (% infect.)
4.5	—[b]	—	24 (33)	39 (13)
5.2	50 (90)[c]	50 (70)	50 (90)[c]	50 (70)
5.8	20 (100)	20 (65)	12 (58)	14 (79)
7.1	20 (100)	20 (100)	17 (100)	24 (96)
7.6	50 (98)	50 (100)	46 (98)	50 (98)

[a] Log_{10} Vero cell PFU/ml.
[b] Not done.
[c] Differs significantly from other strain tested the same day; $P \leq 0.05$ in Fisher's exact test.

Table 6. Ross River virus transmission rates by Hawaiian and Houston strains of *Aedes albopictus*.

Titer[a] of infective meal	Day-7 transmission		Day-14 transmission	
	Hawaii	Houston	Hawaii	Houston
	n[b] (% trans.)	n (% trans.)	n (% trans.)	n (% trans.)
5.2	23 (43)	27 (33)	35 (77)[c]	25 (52)
5.8	12 (75)	6 (50)	5 (100)	6 (67)
7.1	10 (90)	17 (53)	9 (100)	11 (64)
7.6	27 (67)[c]	40 (38)	31 (94)	36 (78)

[a] Log_{10} Vero cell PFU/ml.
[b] Number of infected mosquitoes that refed.
[c] Differs significantly from other strain tested the same day; $P \leq 0.05$ in Fisher's exact test.

sons among species of mosquitoes and strains of virus are quite valid since any reduction in sensitivity attributable to the artificial feeding technique should be the same in the paired comparisons.

Our results show that Houston *Ae. albopictus* and Rexville *Ae. aegypti* are readily infected with YF virus by the oral route and that virus transmission rates are similar and substantial (55 and 46%, respectively) on day 11 postinfection. Also, the strains of the two species tested have similar thresholds of infection. Dinger et al. (1929) previously demonstrated that *Ae. albopictus* from Java could transmit YF virus; however, since mosquitoes were tested in groups, it was not possible to quantify infection and transmission rates.

The Houston strain of *Ae. albopictus* is also an efficient experimental vector of RR virus. Infection rates approached 100% following the ingestion of high-titered blood meals, and virus transmission rates also were high (52 to 78%) by day 14 postinfection. Both the Hawaii and Houston strains of *Ae. albopictus* were also capable of transmitting RR virus by day 7 postinfection. These results are in general agreement with those concerning RR virus in *Ae. vigilax* (Skuse), a primary vector in Australia and perhaps Fiji. Kay (1982) showed that *Ae. vigilax* infected *per os* could transmit RR virus by bite 4 days later and that maximum transmission efficiency was reached by 10 to 13 days postinfection. Our results suggest that the Hawaii strain of *Ae. albopictus* may sometimes be a more efficient experimental vector of RR virus than is the Houston strain. Mitchell and Gubler (1987) previously showed that geographic strains of *Ae. albopictus* may vary in their vector competence for RR virus.

In view of the known and potential vector relationship of *Ae. albopictus* with several arboviruses, its establishment in the Western Hemisphere is a justifiable cause for concern. Whether its presence in the United States increases the risk of epidemic dengue transmission is a point that may be debated since *Ae. aegypti* already is present in many of the same areas. However, the fact that all four DEN viruses can be transmitted transovarially by *Ae. albopictus* under experimental conditions (Rosen et al. 1983) warrants concern about its potential as a reservoir for endemic dengue.

The situation in Central and South America and the islands of the Caribbean appears more ominous. *Aedes albopictus* may contribute to dengue transmission and maintenance, and in certain areas, has the potential of bridging the gap between jungle and urban yellow fever cycles. The species may become abundant in the forest fringe and adjacent urban areas. Whether

it might also become established in jungle foci of *Haemagogus*-transmitted YF remains to be seen.

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REFERENCES CITED

Aitken, T. H. G. 1977. An *in vitro* feeding technique for artificially demonstrating virus transmission by mosquitoes. Mosq. News 37:130–133.

Anonymous. 1986a. *Aedes albopictus* infestation—United States, Brazil. MMWR 35:493–495.

Anonymous. 1986b. Update: *Aedes albopictus* infestation—United States. MMWR 35:649–651.

Dinger, J. E., W. A. P. Schuffner, E. P. Snijders and N. H. Swellengrebel. 1929. Onderzoek over Gele Koorts in Nederland (Dedre Medeeling). Nederl. Tijdschr. V. Geneesk. 73:5982–5991.

Forattini, O. P. 1986. Identificacão de *Aedes* (*Stegomyia*) *albopictus* (Skuse) no Brasil. Rev. Saude. Publ. 20:244–245.

Gubler, D. J., S. Nalim, R. Tan, H. Saipan and J. Sulianti Saroso. 1979. Variation in susceptibility to oral infection with dengue viruses among geographic strains of *Aedes aegypti*. Am. J. Trop. Med. Hyg. 28:1045–1052.

Gubler, D. J. and L. Rosen. 1976. Variation among geographic strains of *Aedes albopictus* in susceptibility to infection with dengue virus. Am. J. Trop. Med. Hyg. 25:318–325.

Kay, B. H. 1982. Three modes of transmission of Ross River virus by *Aedes vigilax* (Skuse). Aust. J. Exp. Biol. Med. Sci. 60:339–344.

Kuberski, T. T. and L. Rosen. 1977. A simple technique for the detection of dengue antigen in mosquitoes by immunofluorescence. Am. J. Trop. Med. Hyg. 26:533–537.

Miller, B. R. and C. J. Mitchell. 1986. Passage of yellow fever virus: Its effect on infection and transmission rates in *Aedes aegypti* mosquitoes. Am. J. Trop. Med. Hyg. 35:1302–1309.

Mitchell, C. J. 1983. Mosquito vector competence and arboviruses, p. 63–92. *In*: K. F. Harris (Ed.), Current topics in vector research. Praeger Scientific, New York.

Mitchell, C. J. and D. J. Gubler. 1987. Vector competence of geographic strains of *Aedes albopictus* and *Aedes polynesiensis* and certain other *Aedes* (*Stegomyia*) mosquitoes for Ross River virus. J. Am. Mosq. Control Assoc. 3:142–147.

Reed, L. J., and H. Muench. 1938. A simple method of estimating fifty percent endpoints. Am. J. Hyg. 27:493–497.

Rosen, L. and D. Gubler. 1974. The use of mosquitoes to detect and propagate dengue viruses. Am. J. Trop. Med. Hyg. 23:1153–1160.

Rosen, L., D. A. Shroyer, R. B. Tesh, J. E. Freier and J. C. Lien. 1983. Transovarial transmission of dengue viruses by mosquitoes: *Aedes albopictus* and *Aedes aegypti*. Am. J. Trop. Med. Hyg. 32:1108–1119.

Shroyer, D. A. 1986. *Aedes albopictus* and arboviruses: A concise review of the literature. J. Am. Mosq. Control Assoc. 2:424–428.

Sprenger, D. and T. Wuithiranyagool. 1986. The discovery and distribution of *Aedes albopictus* in Harris County, Texas. J. Am. Mosq. Control Assoc. 2: 217–219.