MOSQUITO STUDIES DURING AN INTEREPIDEMIC OUTBREAK OF DENGUE IN PUERTO RICO [1]

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ABSTRACT. In July 1972, an outbreak of febrile illness with rash involving nearly 3,000 people occurred in the Guánica-Ensenada area of Puerto Rico. Dengue-2 virus was identified as the major etiologic agent both serologically and by virus isolation.

Four larval and adult *Aedes aegypti* surveys were conducted in the area between July and December. Approximately 250 premises were inspected at monthly intervals. The premises indices (percent of premises positive for *A. aegypti* larvae) were 21%, 18%, 33%, and 10% for the four surveys, respectively.

Large (50-gallon) water barrels and old tires were the most common containers with *A. aegypti* larvae. Numbers of adult *A. aegypti* collected per man per hour increased from 1.3 to 2.7 to 4 during the first three surveys, respectively, but fell to 0.7 on the fourth survey.

Epidemics of human illness caused by dengue-3 and dengue-2 viruses occurred in Puerto Rico in 1963–64 and 1968–69, respectively. During the interepidemic period, there was no evidence of endemic dengue activity. However, since 1969, dengue-2 transmission has been documented repeatedly in western and southwestern Puerto Rico serologically and by virus isolation (Morbidity and Mortality Weekly Report, Vol. 21, No. 44).

Aedes aegypti has long been a problem in Puerto Rico. A concerted effort to eradicate this mosquito from the Island was initiated by the U. S. Public Health Service in 1965. However, due to a number of factors, including lack of funds, eradication efforts were abandoned in 1969. No organized mosquito control program presently exists in Puerto Rico and *A. aegypti* populations are probably flourishing once again.

In July 1972, an outbreak of febrile illness with rash involving 3,000 people occurred in the Guánica-Ensenada area of Puerto Rico (MMWR, Vol. 21, No. 44). Guánica-Ensenada is located in the semiarid southwestern part of the island and has a population of about 10,000. The mosquito studies reported here were conducted during this outbreak.

METHODS. Monthly larval and adult mosquito surveys were conducted from August through November 1972 in Guánica, Ensenada, and nearby rural areas. Every fifth house in the area was inspected. Altogether, 256 houses were visited on the first survey and the same houses were revisited during subsequent surveys. All containers present on these premises were inspected for water and mosquito larvae. Premises were considered positive if at least one *A. aegypti* larva was found in a container (Sheppard *et. al.*, 1969). Inspectors searched for adult mosquitoes inside houses, in closets, and bedrooms, and recorded the duration of their search.

One week before the third survey in October, personnel from the Puerto Rico Health Department initiated mosquito control measures. A 2.5 percent malathion [4] solution was applied inside houses from portable sprayers. Perifocal spray-

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TABLE 1.—*Aedes aegypti* larval survey in Guánica-Ensenada, Puerto Rico, August–November 1972.

Subdivision	Number houses examined				Percent houses positive for larvae			
	1st survey	2nd survey	3rd survey	4th survey	1st survey	2nd survey	3rd survey	4th survey
Guánica (1)	70	81	83	78	12.8	9.8	28.9	12.8
Ensenada (2)	67	50	47	43	23.8	28.0	40.4	13.9
Guaypao (3)	26	25	25	25	19.2	24.0	52.0	4.0
Montalba (4)	38	38	38	35	23.6	21.0	28.9	11.4
Colinas (5)	26	26	28	27	30.7	11.5	39.2	7.4
La Joya (6)	29	29	28	27	20.6	17.2	17.9	3.7
Total	256	249	249	235	20.7	17.8	33.3	10.2

ing with malathion was performed outside houses, and Abate 1-G was placed in large water-holding receptacles.

RESULTS. The percent of houses with containers positive for *A. aegypti* (premises index) during the four surveys are presented in Table 1. The premises index varied from 10.2 percent to 33.3 percent.

The principal types of containers harboring *aegypti* larvae are presented in Table 2. Fifty-gallon drums, old tires, and 1–5-gallon cans were the most frequent breeding sites. *A. aegypti* larvae were also collected from a wide variety of miscellaneous containers such as old commodes, washing machines, conch shells, and water-holding plants (bromeliads). Except for two occasions, all positive containers were located outside the houses.

The presence or absence of water and *aegypti* larvae in two common containers is shown in Figure 1. Both 50-gallon drums and old tires were abundant at the houses surveyed. There was marked fluctuation in the number of old tires, but the number of 50-gallon drums was relatively stable.

To determine effects of anti-*aegypti* measures, we analyzed prevalence of *aegypti* larvae in containers from matched houses before and after treatment which was applied between the second and third surveys (Table 3). There was a reduction of positive containers on treated premises and a marked increase in positive containers on untreated premises. The most dramatic decrease of positive containers after Abate treatment was in the 50-gallon drums. Thus, anti-*aegypti* measures lowered larval populations on treated premises.

TABLE 2.—Summary of containers with *Aedes aegypti* larvae in Guánica-Ensenada, Puerto Rico, August–November 1972.

Type of container	1st survey		2nd survey		3rd survey		4th survey	
	Number positive	% of total	Number positive	% of total	Number positive	% of total	Number positive	% of total
50-gallon barrels	22	35.4	29	35.9	18	14.2	8	21.0
1–5-gallon cans	12	19.4	12	14.8	20	15.7	7	18.4
Animal watering pans	10	16.2	4	4.9	18	14.1	4	10.5
Old tires	6	9.6	16	19.8	27	21.2	7	18.4
Buckets	4	6.4	8	9.8	14	11.2	2	5.2
Miscellaneous	8	13.0	12	14.8	30	23.6	10	26.5
Total	62		81		127		38	

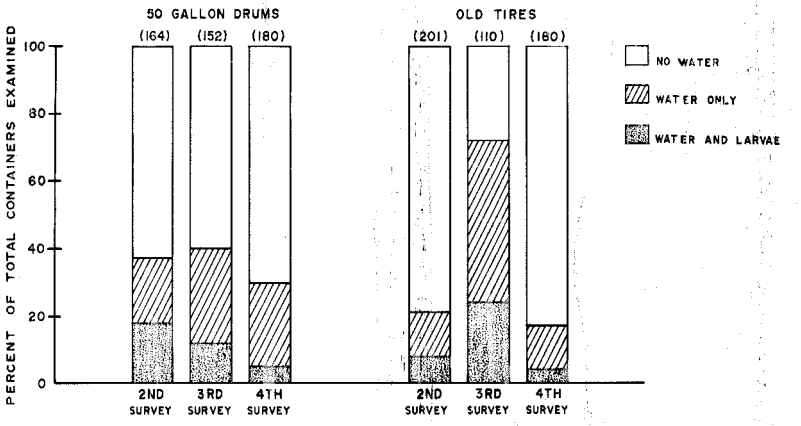

FIG. 1.—Results of 3 surveys for presence of water and mosquito larvae in 2 common breeding containers, Guánica-Ensenada, Puerto Rico (Sept.–Nov., 1972).

Numbers of adult *A. aegypti* collected per man per hour increased from 1.3 to 2.7 to 4 during the first three surveys, respectively, but fell to 0.7 on the fourth survey.

DISCUSSION. These surveys indicate that *A. aegypti* is well established in the dry south coastal areas of Puerto Rico. Female *aegypti* oviposit in a variety of containers, but 50-gallon drums and old tires probably represent important semipermanent oviposition and breeding sites. Even though piped water is available in the houses, many families in the Guánica-Ensenada area collect and store rain water in 50-gallon drums for various domestic purposes. In addition, smaller water-holding receptacles are abundant on most premises.

About 2 weeks before the third survey, heavy rains occurred in the Guánica area. This precipitation provided many new oviposition sites for female mosquitoes and probably explains the explosive increase in both larval and adult *aegypti* populations observed in the third survey. Long-term studies are needed to evaluate seasonal population fluctuations of *aegypti* in Puerto Rico.

Malathion has been the principal insecticide used by the Puerto Rico Health Department for mosquito control. However,

TABLE 3.—Numbers of containers positive for *Aedes aegypti* larvae from matched treated (96) and untreated (134) premises, Guánica-Ensenada, Puerto Rico, September–October 1972.

Container	Treated premises[a]		Untreated premises	
	2nd survey	3rd survey	2nd survey	3rd survey
50-gallon drums	16	0	13	16
1–5-gallon cans	7	5	9	15
Animal watering pans	1	6	3	12
Old tires	9	6	7	18
Buckets	4	4	1	9
Miscellaneous	1	6	3	12
Total	38	27	36	82

[a] Treatment applied between 2nd and 3rd surveys.

Fox and Bayona (1972) noted that some malathion-resistant strains of *A. aegypti* have appeared in Puerto Rico. Thus, it is possible that alternative methods such as source reduction or other insectides should be considered for future *A. aegypti* control.

Abate has been shown to be an effective *A. aegypti* larvicide (Gould *et. al.*, 1971) and there is no indication of resistance to this compound in Puerto Rico. In this study, mosquito larvae were suppressed in 50-gallon drums by the application of Abate. However, since it was not feasible to treat small containers, many of these harbored *aegypti* larvae after heavy rains in October (Table 3). Effective source reduction is an obvious solution to the problem of *aegypti* breeding in small containers.

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THE PERSISTENCE OF HEPATITIS B ANTIGEN IN *AEDES AEGYPTI*

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Hepatitis B (long-incubation hepatitis) is associated with an antigen (HBAg) which is known to be transmitted by parenteral injections or blood transfusions. The high incidence of HBAg in human populations in the tropics has suggested that blood-sucking arthropods might serve as vectors (Prince, 1970, and Shulman, 1970). Furthermore, since mosquitoes serve as efficient vectors of a variety of viruses, we believe that their possible role in transmission of this antigen should be investigated.

We initiated a study, the first phase of which was designed to determine whether or not hepatitis B antigen persisted, with or without multiplication, for a sufficient period of time for mosquito transmission to be a possibility. This report deals with the persistence of HBAg in *Aedes aegypti*.

MATERIALS AND METHODS. Batches of 40 *A. aegypti* 4–6 days of age, in half-pint ice cream containers with nylon netting glued to top, were placed on the anterior aspect of the forearm and/or abdomen of each of two volunteer chronic asymptomatic carriers of HBAg, known to have stable antigen titers. The containers from these and a normal (anti-

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