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Suppression of a field population of *Aedes aegypti* by malathion thermal fogs and Abate larvicide

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In previous field studies, a field population of *Aedes aegypti* was suppressed by larviciding water containers with 1% Abate [4] sand granules.[5] However, the decline in the population following initial treatment was gradual, a factor that might limit the use of a larvicidal treatment by itself during an epidemic of dengue haemorrhagic fever. Immediate control of adult populations can be achieved by the application of insecticidal thermal logs, although the application must be repeated several times, as it has been found in previous field trials at the ARU (unpublished data) that the mosquito density returns to the pretreatment level within a week. A combined treatment by the two different methods i.e., adulticiding and larviciding, appears to be desirable in combining an emergency operation and a long-term control programme. The exact rate of the reduction in adult mosquito populations and their recovery in an area where all larval habitats are treated with Abate is not known.

The investigation reported in this paper was carried out in Bangkok by the World Health Organization *Aedes* Research Unit (ARU) to determine the efficacy of malathion thermal fogs, applied soon after larviciding by 1% Abate sand granules, on the suppression of a field population of *Ae. aegypti* and its recovery. This was one of a series of field studies undertaken by the ARU to devise emergency control measures that can be recommended when an epidemic occurs.

Description of the area

The study was carried out in a housing area of Bang Sue, in the northern part of Bangkok, which had an area of approximately 7 ha, was 830 m in length and 85 m in width, and was divided into two unequal parts by a playground (0.5 ha); the two parts were used for evaluation of the two different treatments. There are 52 apartment buildings, and 304 houses in the treated area: 172 in site A and 132 in site B. The structure of the houses at the two sites were alike and similar to those described by Bang et al.[5]

To determine the rate of reduction of the adult mosquito population in an area where there was no mosquito infiltration from untreated neighbour-

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[4] *O,O,O',O'*-tetramethyl *O,O'*-thiodi-*p*-phenylene phosphorothioate.

[5] Bang, Y. H. et al. (1969) *Pilot studies of Abate (OMS 786) as a larvicide for controlling* Aedes aegypti *in Bangkok* (Unpublished document WHO/VBC/69.164).

hoods, an isolated village (1 ha) of 72 houses was selected in the Huay Kwang district of Bangkok. Most of the houses in this area have two storeys and are built of wood on raised platforms over standing water. The houses are interconnected with boardwalks.

The untreated control area, consisting of 150 houses occupied by low-income families, was located in Sutisan about 1 km south of the treated area of Bang Sue. The two-storey wooden houses were similar to those of Huay Kwang village.

Each building had an average of 8 water containers, half of which were jars. The container index for *Ae. aegypti* was approximately 35% in Bang Sue and in the untreated control area, this being slightly lower than that found in Huay Kwang village (46%).

Materials and methods

In Bang Sue, all larval habitats in both sites were treated within 2 days with 1% Abate sand granules at a target dosage of 1 ppm. Two days later, site A (3 ha) was treated with 4% malathion thermal fog by 2 Swingfogs at a target dosage of 420 ml/ha between 07.00 hours and 09.00 hours. Each building was treated from the front door and the areas between the houses were also fogged.

The larval habitats were examined weekly in 60 houses selected at random in each area for a month before the treatment. The first larval survey was conducted 3 days after the treatment; subsequently, surveys were made at irregular intervals for 27 weeks. Adult mosquitos landing on human bait were collected by two collectors at 12 stations selected at random in each site. The weekly collecting programme commenced 2 months prior to the larvicidal treatment. Following the treatment the catches were made every 2 days for 2 weeks and then at different intervals for 16 weeks. The extent of the initial reduction of adult density in the selected site was determined one day after the malathion thermal fogs were applied. Oviposition traps (Fay & Perry, 1965) were employed to collect eggs in the treated areas. Two traps were set each week outside and inside each of 20 houses selected in each area for 6 weeks prior to the treatment: the first set of paddles was put in place immediately after each treatment. The paddles were replaced by new ones every 2 days for 2 weeks and then weekly for 3 months. After exposure for 2 days, each paddle was returned to the laboratory and examined for eggs with a microscope.

In Huay Kwang village, larviciding was completed on a single day, each container being treated at a dosage rate of 1 ppm. The adult collection was made by two collectors at 12 houses selected at random on each collecting day. The catches were made daily for the first 3 days after the larviciding and thereafter at irregular intervals for 27 weeks. All the water containers were routinely inspected. The egg-collection programme was not conducted in the village or in the control area.

Results

The average amount of 1% Abate sand granules used per house in Bang Sue was 85 g (9.2 g per container). Larvae of *Ae. aegypti* were not found in any container 3 days after the larvicidal treatment (Fig. 1). After 8 weeks, when the adult density started to increase again, the containers began to show larval breeding, and the receptacle index reached the pretreatment level 27 weeks later. No significant difference was observed in the recovery rates in the two treated areas during the first 12 weeks after the larvicidal treatment. After 13 weeks, however, the percentage of reinfestation was lower in the site that had been treated by larviciding and adulticiding than in the area treated with larvicide only. This difference appeared to have resulted from the initial reduction of the adult mosquito population by the application of 4% malathion fogs in site A.

Unlike the receptacle index, the adult mosquito density declined gradually in the site treated with Abate granules only (Fig. 1). The average number of adult mosquitos caught per man hour was reduced from 7.9 to 1.8 (77.7%) during the first 5 days. Two weeks after this treatment, the level was approximately 90% lower than the pretreatment level, and thereafter no further reduction was obtained. During the initial reduction period one-third of the adults caught were females. In the area treated with malathion fogs only a single male was caught 24 h after treatment and the reduction was approximately 96%. The adult density started to recover 3 days after treatment but was slightly lower than in the comparison area for about 3 weeks after the fogging. The average number of adults caught increased gradually and returned to the pretreatment level in both the treated areas 12 weeks later. As the adult population declined, the percentage of positive ovitraps dropped to nil for 4 days following the malathion fogging (Table 1). On the other hand eggs were always found in the ovitraps in the site treated with larvicide only. After 10 days the average pro-

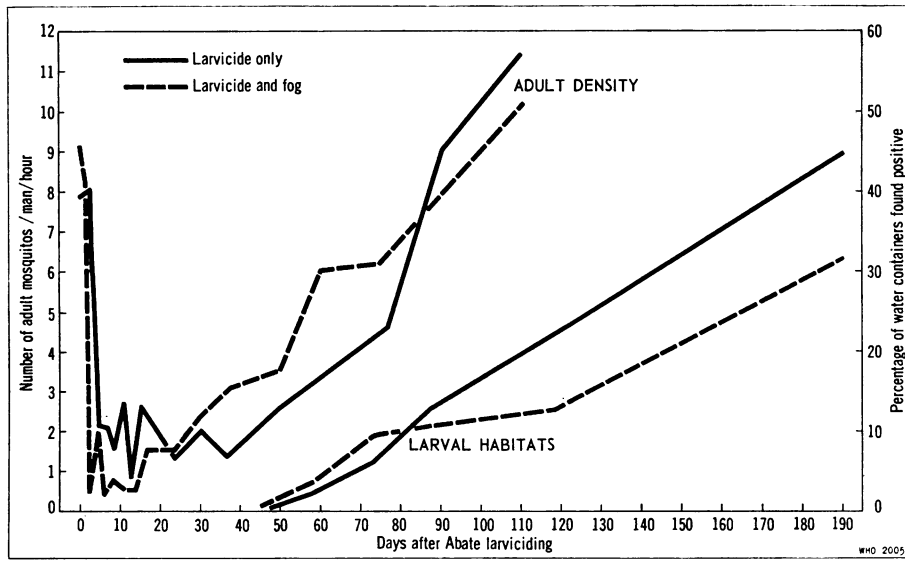

Fig. 1. Density of adult *Aedes aegypti* and number of habitats found to contain larvae in the two treated areas in Bang Sue, Bangkok.

Table 1. Percentage of ovitraps containing eggs of *Aedes aegypti* in the 2 treated areas in Bang Sue (average of 20 traps)

No. of days after larviciding	Larviciding and fogging			Larviciding only		
	Indoor	Outdoor	Mean	Indoor	Outdoor	Mean
Before	45	30	37.5	13	29	21.0
2 [a]	70	50	60.0	35	50	42.5
4 [b]	0	0	0.0	20	50	35.0
6	0	0	0.0	0	15	7.5
8	5	5	5.0	25	45	35.0
10	20	5	12.5	20	35	27.5
12	10	10	10.0	0	15	7.5
19	15	5	10.0	15	15	15.0
25	20	25	22.5	20	30	25.0
37	25	5	15.0	20	15	17.5
50	25	5	15.0	30	15	22.5
61	35	0	17.5	10	20	15.0
73	40	20	30.0	20	30	25.0
86	25	40	32.5	20	20	20.0

[a] The ovitraps were placed in position immediately after the larviciding.
[b] The ovitraps were placed in position 1 hour after the treatment with malathion thermal fogs.

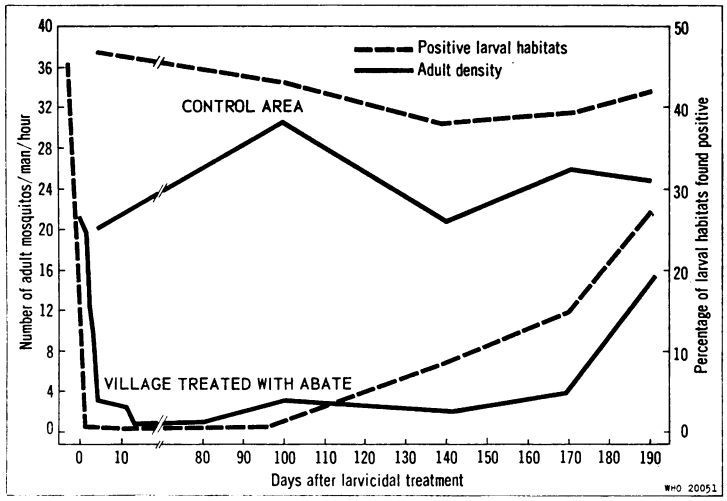

Fig. 2. Density of adult *Aedes aegypti* and number of habitats found to contain larvae in the isolated village of Huay Kwang and in the control area.

portion of positive ovitraps was not significantly different in the two treated areas.

When an isolated village was treated at the same dosage, the rate of reinfestation of containers by larvae was much slower than that found in the Bang Sue area, which is bordered by an untreated area. An increase in the number of positive containers was first recorded 20 weeks after the larvicidal treatment—much earlier than the rise in adult density (Fig. 2). Only 15% of the treated containers were positive 24 weeks after the application of the larvicide. The proportion of positive containers in the untreated check area showed a decrease of approximately 10% during the 7-month period from April to November (Fig. 2). As in the Bang Sue area, a sharp reduction in adult density occurred in Huay Kwang village during the first 5 days (Fig. 2) but it was 2 weeks before the maximum reduction of approximately 99% was reached. However, the reduction was less marked in the male population. The adult population in the village began to recover about 12 weeks after the treatment. Although 15% of the receptacles were infested with larvae, the adult population was reduced by 90% even 24 weeks after the larvicidal treatment.

Discussion

The dispersal of 4% malathion thermal fogs by ground equipment almost eliminated the field population of adult *Ae. aegypti* and no egg laying occurred for 4 days after the fogging. Recovery of the field population, which occurred rapidly in an area treated with malathion fogs alone, was largely suppressed by the application of 1% Abate sand granules to water containers.

In the area treated with Abate granules only, the adult density declined gradually and reached a very low level only after 2 weeks. Afterwards 1 or more mosquitos were always caught per man hour. The rate of reduction in adult density was greater when an isolated village was treated on a single day. However, the reduction was not complete as it was in the area treated with malathion fogs. In the two areas that were treated with Abate but not with malathion, the female population took about 2 days longer to decline than the male population. In both sexes a sharp reduction occurred in the first 5 days following treatment: during this period the number of females caught was less than two per man hour. In a large operation, however, the rate of reduction would be slower than this because all the containers could not be treated on a single day and some of the receptacles would certainly remain untreated. This was demonstrated in a pilot control study in Bangkok[1] in which ant traps and other temporary receptacles were treated at a later date, following

[1] See footnote 5, page 554.

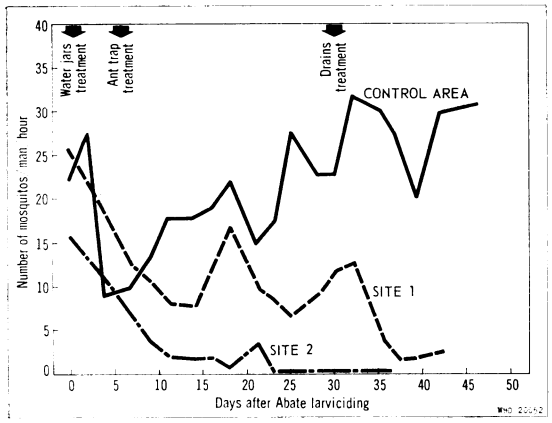

Fig. 3. Effect of Abate larvicide on the density of adult *Aedes aegypti* at the three evaluation sites of the Makkasan pilot control area.

the treatment of water jars and other larger containers with larvicide (Fig. 3). Because the first application of larvicide had missed some of the larval breeding sources (cement drains), adult density remained unchanged for 5 weeks (Fig. 3, site 1) after the initial reduction.

In all the areas treated with Abate larvicide, irrespective of additional malathion fogging, the adult population did not begin to increase until 6 or 7 weeks after the treatment (Fig. 1): the reinfestation of water containers appeared to begin at about the same time. Effective control of larvae was obtained for approximately 8 weeks, and was not remarkably prolonged by the application of 4% malathion fogs. The longest period of effective control was 14 weeks when all the larval habitats in the isolated village were treated (Fig. 2). The adult population did not begin to increase until 24 weeks after treatment.

The data obtained from the present study suggest that a single application of the larvicide might be sufficient to control mosquito populations if dengue haemorrhagic fever outbreaks were confined to the rainy season, from May to November (Halstead, 1966). However, treatments with Abate larvicide alone or Abate in conjunction with insecticide fogs have yet to be studied in areas of an actual epidemic.

ACKNOWLEDGEMENTS

We are grateful to Dr Boonluan Panthumchinda, Department of Medical Sciences, for her invaluable assistance in solving field problems. We are also indebted to Mr Anek Ruangsri for his technical assistance. This study was supported jointly by US Public Health Service research grant no. CC 00174 from the National Communicable Disease Center, Atlanta, Ga., USA, and by the World Health Organization.

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Lyophilisation d'antigènes figurés destinés aux tests d'immunofluorescence du paludisme: résultats préliminaires *

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Dans ses applications au sérodiagnostic du paludisme, la réaction d'immunofluorescence indirecte offre comme principal avantage pratique de n'exiger qu'une très minime quantité de sang parasité pour la préparation des antigènes figurés. Avec ce matériel, on réalise des étalements minces ou bien encore des gouttes épaisses suivant la technique de Sulzer & Wilson (1967). Après séchage, ces préparations peuvent être conservées pendant plusieurs mois à

* Travail effectué avec l'aide financière de l'Organisation mondiale de la Santé.

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