Operation note on dengue vector control against *Aedes albopictus* in Chiba City, Japan, where an autochthonous dengue case was confirmed in September 2014

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**Abstract:** An autochthonous dengue patient was confirmed on September 8, 2014 in Chiba City, Japan and emergency control against potential dengue vector *Aedes albopictus* was implemented in the residential area where the case was found. We examined the distribution of human dwellings and areas with trees and bushes in the residential area by using an aerial photograph, selected an operation area within 100 m radius of the patient’s house, and carried out vector survey and insecticide spray in the operation area. The mean biting density of *Ae. albopictus* examined at six collection sites within the operation area was 2.8/person/8 min before insecticide applications. Etofenprox 7% and phenothrin 10% diluted 1/50 were applied to adult resting sites and larval habitats of *Ae. albopictus* at a rate of 500 mL/m² and 50 mL/m² with a power-driven sprayer and hand-pump sprayers, respectively. Additionally, a liquefied carbon dioxide formulation of phenothrin was applied at a rate of 1 g/m² to drains with a heavy cover. The mean biting density was reduced to 1.2/person/8 min on the same day after insecticide application, and weekly inspections of the operation area in the following 3 weeks found a total of four mosquitoes.

**Key words:** autochthonous dengue case, *Aedes albopictus*, vector control, etofenprox, phenothrin

**Introduction**

A total of 160 autochthonous dengue patients were reported from August to October 2014, mainly from Tokyo, Japan (Ministry of Health, Labour and Welfare, 2014). Among Japanese mosquitoes, *Aedes albopictus* (Skuse) is susceptible to dengue virus (Eshita et al., 1982) and distributes widely in urban parks in Tokyo (Tsuda, 2013). Most of the dengue patients were considered to be bitten by infected *Aedes albopictus* when they visited Yoyogi Park and its vicinity in Tokyo (Arima et al., 2014). However, one patient who had never been in Yoyogi Park or dengue transmission areas in foreign countries was found in Chiba City on September 8, 2014. Because there was a possibility that infected *Ae. albopictus* were inhabiting the vicinity of the patient’s house, an emergency vector survey was implemented and insecticide was applied to kill adult mosquitoes and to prevent the spread of dengue virus. This paper described the details of the vector survey and control conducted in Chiba City, Japan, in September 2014.

**Materials and Methods**

*The operation area and vector survey:* The distribution of human dwellings and areas with trees and bushes in the residential area where the patient lived was examined by using an aerial photograph. The residential area was surrounded by a high way, a railroad line, wide roads and parking areas. Considering the dispersal ability of *Ae. albopictus* (Takagi et al., 1995a, b; Tsuda, 2013: Tsuda and Kamezaki, 2014), an area within 100 m radius of the patient’s house was selected as the operation area (Fig. 1) where vector survey was carried out and places for insecticide spray were selected. A park outside the operation area, site B in Fig. 1, was examined additionally because it was a public space and people visited and stayed there in daytime. Suitable places for resting adults and larval habithat of *Ae. albopictus* in the operation area were examined and six sites with dense vegetation, A to F in Fig. 1, were selected for human bait sweeping collection of mosquitoes. A collector stayed at the collection site for 8 min in daytime, between 13:00 to 16:00, and collected all mosquitoes attracted to a collector by a hand net (36 cm in diameter). The collected mosquitoes were identified morphologically following Tanaka et al. (1979). The biting density of *Ae. albopictus* was examined on September 9, 2014 and the insecticide was sprayed on September 10, 2014.
evaluate the efficiency of the insecticide spray, the biting density was examined again by human bait sweeping collections 2 hours after insecticide spray, and thereafter the presence of mosquitoes was examined weekly by visual inspection for 3 weeks. Instead of the sweeping collection, a collector staying at each collection site for 8 min in daytime counted by eye the number of mosquitoes flying around.

Insecticide applications: The date and area of insecticide spray was announced to neighboring inhabitants in advance, and their approval was acquired before the operation. Two kinds of water-based microemulsions, etofenprox 7% (w/w) (Mitsui Chemicals Agro Co., Ltd., Tokyo, Japan) and phenothrin 10% (w/w) (Sumika Environmental Science Co., Ltd., Hyogo, Japan), diluted 1/50 were applied to adult resting sites (mainly plants) and larval habitats of *Ae. albopictus* at a rate of 500 mL/m² and 50 mL/m² with a power-driven sprayer (OHV, Kubota Agricultural Machinery Co., Ltd. Tokyo, Japan) and hand-pump sprayers (B & G Co., Ltd., Texas, U.S.A.), respectively. A liquefied carbon dioxide formulation of phenothrin 1% (w/w) (Japan Liquid Charcoal Co., Ltd. Tokyo, Japan) was used for the application of phenothrin by using a CO₂ gas and applied at a rate of 1 g/m² to drains with a heavy cover in this study.

Three different application methods, power-driven sprayer, hand-pump sprayer, and the spray of carbon dioxide gas formulation, were used in this study depending on the application target. There were various targets for insecticide application in the operation area, including private houses, a park, a densely vegetated area, hedges, and drainages, so it was difficult to spray insecticide by using only one method. A power-driven sprayer was used to apply a diluted etofenprox to dense vegetation areas and large areas where a high power was necessary, and hand pump sprayers were used to apply a diluted phenothrin to narrow and/or small spaces, such as behind and/or under vending machines and washing machines, hedges, and water drain pipe on the wall. The drains with a heavy cover surrounding a park was suspected to provide resting sites for adults and larval habitats, however only small holes on the cover were available for insecticide application so a liquefied carbon dioxide formulation of phenothrin was used.

**Results and Discussion**

Results of mosquito collections are summarized in Table 1. A total of 17 mosquitoes were collected and identified as *Ae. albopictus*. The mean biting density before and after the insecticide application was 2.8/ person/8 min and 1.2/person/8 min, respectively, and the difference was significant (Paired *t*-test, *p*=0.031). Although insecticide application clearly reduced the average biting density of the *Ae. albopictus* population, sites, C, D, and E in Fig. 1 where mosquitoes were collected 2 hours after application were sprayed with insecticide again on September 10, 2014 to ensure the elimination of infected *Ae. albopictus* from the operation area. During the three weeks following the insecticide application, only 4 mosquitoes were observed by visual inspection.

![Fig. 1. Operation area within 100 m radius of the patient's house for dengue vector control against *Aedes albopictus* in Inage-ku, Chiba Prefecture, 2014. Black (A): Patient's house. Gray (B, C, D, E): Areas where insecticide was sprayed. The residential area where the patient lived was surrounded by a high way, a railroad line, wide roads and parking areas.](image)

### Table 1. Results of human bait sweeping collection and visual inspection of *Aedes albopictus* in Inage-ku, Chiba, Japan in 2014.

| Collection site | Human bait sweeping collection | Visual inspection |
|----------------|--------------------------------|------------------|
|                | 9 Sep. | 10 Sep. | 16 Sep. | 24 Sep. | 3 Oct. |
| A              | 1      | 0       | 0       | Not examined | 0 |
| B              | 4      | 0       | 0       | 0       | 0 |
| C              | 5      | 3       | 0       | 0       | 0 |
| D              | 2      | 1       | 0       | 0       | 3 |
| E              | 5      | 3       | 0       | 0       | 0 |
| F              | 0      | 0       | 0       | 1       | 0 |
| Total          | 17     | 7       | 0       | 1       | 3 |
| Mean (SD)      | 2.8 (2.1) | 1.2 (1.5) | 0       | 0.2 (0.4) | 0.6 (1.3) |

The insecticide was applied on 10 September 2014 and mosquito collection was conducted 2 hours after insecticide spray.
The seasonal prevalence of *Ae. albopictus* in the Kanto Plains area is characterized by increasing and decreasing periods of the population occurring from May to August and September to October, respectively (Kosone et al., 2004, 2005; Tsuda and Kim, 2012; Tsuda and Hayashi, 2014). When the dengue patient of this study was found in mid-September, it seemed that the vector population was in the decreasing period and the larval control was less important than the adult control to prevent dengue virus transmission. Therefore, the main purpose of the insecticide spraying in this study was eliminating infected *Ae. albopictus* to prevent the spread of dengue virus near the patient’s house. No *Ae. albopictus* were found six days after application in this study, indicating the successful elimination of *Ae. albopictus* females from the operation area. The time period required for *Ae. albopictus* population to recover from the application of phenothrin and etofenprox was estimated to be 4 to 5 days, and the re-appearance of mosquitoes 2 to 3 weeks after application in this study supported the estimation (Ogata et al., 2012).

Females of *Ae. albopictus* use a variety of resting sites of different size and structure, such as a densely vegetated area, hedges, small spaces under vending machines and washing machines, drains, and water drain pipes on the wall. And it is difficult to apply insecticide to mosquitoes staying at a wide variety of resting sites by using only one application method. To prevent dengue transmission, a quick and effective vector control is required, so it is recommended to provide various application machines as well as enough man power for emergency vector control in the future.

When autochthonous dengue cases appear, it is recommended to reduce the risk of spreading dengue virus by reducing the vector density in the suspected area of transmission while minimizing the adverse effects of insecticide on the environment and ecosystem (Bureau of Social Welfare and Public Health, Tokyo Metropolitan Government, 2014). In this study, we applied insecticide, focusing on adult resting sites and selected an appropriate method of insecticide spraying to minimize side effects of insecticide on the environment.

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