LA UNTADITA: A PROCEDURE FOR MAINTAINING WASHBASINS AND DRUMS FREE OF Aedes aegypti BASED ON MODIFICATION OF EXISTING PRACTICES

CATALINA SHERMAN, EDUARDO A. FERNANDEZ, ADELINA S. CHAN, REINA C. LOZANO, ELLI LEONTSINI, AND PETER J. WINCH

Division de Enfermedades Transmitidas por Vectores, Ministerio de Salud Publica, Tegucigalpa, Honduras; Department of International Health, The Johns Hopkins University, School of Hygiene and Public Health, Baltimore, Maryland

Abstract. Chlorine bleach and detergent are routinely used by householders in El Progreso, Honduras in the process of cleaning washbasins and drums, the two most important larval habitats of Aedes aegypti in the city. The efficacy of these materials in eliminating eggs, larvae, and pupae of Ae. aegypti was assessed under controlled conditions. The promising results obtained led to trials using a combination of chlorine bleach and detergent to apply to the walls of washbasins and drums as a method for eliminating eggs. The bleach maintained its ovicidal properties when mixed with detergent, and the detergent gave the mixture consistency so that it could be applied as a thin film to the walls. This new procedure was named the little dab (Untadita in Spanish) and allows households to direct their efforts against a stage of the mosquito life cycle that has been ignored in the past: the egg.

The first confirmed cases of dengue in Honduras occurred in 1977. Since that time dengue transmission has become endemic, and large epidemics were documented in 1978, 1987, 1989, 1991, and 1995.1 All four dengue serotypes are now circulating in the country, and there were at least 30 confirmed cases of dengue hemorrhagic fever during the most recent epidemic in 1995. The Integrated Dengue Control Project has been conducting field research since 1991 on community participation in reduction of larval container habitats of the disease’s mosquito vector Aedes aegypti (Linnaeus). The site for the research has been El Progreso, a rapidly growing city of 100,000 on the north coast of Honduras.2

Storage of water for domestic use is common where water supply is deficient or unreliable.3,4 This applies to El Progreso, where rapid and unplanned growth has made it increasingly difficult for city authorities to supply all residents with basic services such as potable water. In this city, concrete washbasins and metal drums account for 25–72% and and 8–20%, respectively, of the Ae. aegypti larval habitats, depending on the neighborhood and the season.5 They play an important role in maintaining mosquito populations during the dry season when other common containers such as tires and metal cans are dry.

Washbasins are rectangular, made of cement, and usually have a drain at the bottom. The surface of the water may be completely uncovered, or partially covered by a built-in horizontal washboard made of corrugated cement and used for washing clothing. In El Progreso, the water is used for washing clothing and dishes, mopping, watering plants, bathing, and only rarely for cooking or drinking. The water is in constant use and runs out quickly, but the washbasin frequently is filled up again before being emptied completely, allowing mosquito larvae remaining at the bottom to complete their life cycle. Continuing interruptions of the water supply have led householders to construct larger washbasins, ranging in size from 380 to 1,110 liters. Metal drums have a volume of 204 liters and no drain at the bottom. In houses with a washbasin they are used as an additional container for water storage.

Initially, the project instructed householders to clean their washbasins and drums at least once and preferably two or three times per week to keep them free of mosquito larvae. However, even where these recommendations were closely adhered to, little or no decrease could be observed in the percent of washbasins and drums harboring mosquito larvae, for the following reasons. 1) Cleaning the washbasin or drum frequently does not entail emptying it out completely. Regarding the drum, in particular, there is the added difficulty of the absence of a drain. When the containers are filled again, the remaining larvae can complete their life cycle. 2) The frequency of cleaning is irregular, depending on both the availability of water and the time constraints of the housewife, to whom the responsibility for cleaning usually falls. 3) The immediate aim of the person cleaning is usually to remove the algae found on the walls below the water line, and few people are aware that the eggs attached to the wall above the water line must also be removed to eliminate all mosquito larvae. Successful removal of the algae results in a washbasin that appears clean, yet the irregular scrubbing of the walls has removed few eggs. The remaining eggs can hatch and develop into adult mosquitoes within days. 4) The built-in washboard makes it difficult to clean all parts of the washbasin because it is difficult to clean either the underside of the washboard or the vertical walls immediately below it, both of which were found in our trials to contain the highest quantity of deposited eggs. 5) In trials conducted in our laboratory, subsequent to scrubbing of egg-infested walls with a commercially available brush, many eggs were found to survive and later hatch either at the bottom of the washbasin or in the bristles of the brush. In one experiment, 2,079 eggs were initially located on the wall of a drum. Thirty seconds of scrubbing with the brush resulted in 442 (21%) being removed from the wall, but hatching as larvae in the water at the bottom, and 189 (9%) becoming wedged in the bristles of the brush and hatching after the brush was immersed in water. Brushing therefore only eliminated 64% of the eggs in this case. It was obvious that scrubbing with a brush in isolation was an ineffective method of control.

In previous phases of the project, it was believed that the irregular water supply, coupled with the ineffective methods used by householders to clean washbasins and drums, indicated that neither was amenable to cleaning-related control methods.6 A number of alternative approaches were consid-
phosphate and sodium carbonate), biological additives, anionic and nonionic surfactants, water softeners (sodium is 48 grams, with sanitary registration number V-00014. The weight of a plastic sachet of detergent (Unox sodium hypochlorite listed on the packaging. The weight of concentration number V-00016 and an active ingredient of 5.25% San Pedro Sula, Honduras) is 210 ml, with sanitary registration number V-00016 and an active ingredient of 5.25%

A method for eliminating the eggs of Ae. aegypti was developed in washbasins involving the application of a combination of chemicals already used by householders to clean their washbasins and drums. First, a high percentage of householders were using chlorine bleach, detergent, and other materials to clean their washbasins and drums. In a survey conducted in September 1995, 757 of the 915 respondents (83%) stated that they use chlorine bleach to clean their washbasins, 380 (42%) use detergent, 134 (15%) use bar soap, and 449 (49%) scrub the walls with a brush. Bleach and detergent were therefore selected for tests of their efficacy in eliminating mosquito larvae and eggs. Second, some people stated that they were adding chlorine bleach to the water after cleaning and refilling their washbasins to keep them free of larvae. Third, it was desirable to develop an intervention that would be both low-cost and could also be maintained with little or no outside technical expertise. Modifying the use of materials already used in the process of cleaning, instead of introducing a new chemical or biological control agent, was seen as ensuring that the resulting recommendation would be low-cost and acceptable to the household. Finally, some householders claimed that although they were cleaning their washbasins according to instruction, larvae would re-appear in as little as two days, and this was very discouraging to them. While they attributed this to the presence of larvae in the tap water, a more straightforward explanation was that they were not doing anything specifically to destroy mosquito eggs on the walls of these water storage containers.

The current study had two objectives: 1) to evaluate the efficacy of chemicals already used by householders to clean their washbasins and drums, chlorine bleach and detergent, in eliminating the eggs, larvae, and pupae of Ae. aegypti; and 2) to evaluate the efficacy of a procedure for cleaning washbasins involving the application of a combination of chlorine bleach and detergent to the walls of washbasins as a method for eliminating the eggs of Ae. aegypti.

**MATERIALS AND METHODS**

**Materials tested.** All materials used were of the same type and quality as used by residents of the study neighborhoods. The trials were conducted with tap water at 29°C, and eggs, third and fourth instar larvae, and pupae produced in the insectary from Ae. aegypti collected in El Progreso. The chlorine bleach and detergent used in the study were purchased locally at a cost of US $0.15 and US $0.11, respectively, per plastic sachet. The volume of a plastic sachet of chlorine bleach (Magia Blanca®; Industrias Magna SA, San Pedro Sula, Honduras) is 210 ml, with sanitary registration number V-00016 and an active ingredient of 5.25% sodium hypochlorite listed on the packaging. The weight of a plastic sachet of detergent (Unox®; Industrias Magna SA) is 48 grams, with sanitary registration number V-00014. The ingredients listed by the manufacturer on the packaging are anionic and nonionic surfactants, water softeners (sodium phosphate and sodium carbonate), biological additives, agents to preserve color, and fabric softeners. Both undiluted chlorine bleach and diluted detergent are alkaline.

**Effect of chlorine bleach and detergent on larvae, pupae, and eggs.** The study was divided into two phases. In the first phase the effect of each individual material on Ae. aegypti larvae, pupae, and eggs was examined, while the second phase assessed a combination of the materials. In a series of assays to measure the time required for each agent to kill 50% of the third and fourth instar larvae, the doses of chlorine bleach used were 2 ml, 10 ml, 26 ml (four tablespoons), and 52 ml (eight tablespoons) per liter of water. The doses of detergent were 5 g, 15 g, 34 g (two tablespoons) and 68 g (four tablespoons) per liter of water. Quantities were chosen in units (tablespoons) that would be of relevance to householders. The dose of the agent being studied was added to one liter of water and stirred to achieve homogeneity, and small a hand-held net containing 50 third and fourth instar larvae was then lowered into the water. For each trial there was an untreated control. During the first hour of the experiment observations were made every 5 min. Dead larvae were removed at each observation. The procedure for testing the effect on pupae was identical.

For the assays with eggs, strips of paper containing 100–120 eggs were placed in metal trays containing one liter of water, the same doses of chlorine bleach or detergent as used in the assay with larvae and pupae were added and left for 48 hr. For each trial there was an untreated control. After 48 hr, the strips of paper containing the eggs were transferred to trays containing one liter of fresh water and left for three more days. After this time immature forms of Ae. aegypti present in the water were counted. At the same time, assays were conducted in petri dishes of the effect of 6.5 ml (one tablespoon) of undiluted chlorine bleach on strips containing approximately 105 eggs each. During the assay the eggs were observed under a stereo microscope (4× magnification). When the black color of the eggs had disappeared, 50 ml of fresh water was added and after waiting 15 min the strip of eggs was again observed under the stereo microscope.

**Effect of a mixture of chlorine bleach and detergent on eggs in washbasins.** Based on the results obtained during the first phase, in the second phase, a mixture of chlorine bleach and detergent at a ratio of 5:1 was applied to the walls of washbasins containing Ae. aegypti eggs and located in the patio of the laboratory. Each washbasin had two compartments, each with a volume of 130 liters, and did not have a washboard. The washbasins were relatively new, and the walls were not as smooth as in a brand new washbasin nor as rough as in an older washbasin.

Adult mosquitoes were induced to lay eggs on the side of the washbasins in two ways. 1) The washbasins were filled halfway with water, covered with a tight-fitting screened cap, and then 150 adult mosquitoes were introduced. The mosquitoes were fed daily during a period of three weeks until an acceptable number of eggs had been laid on the walls. 2) The washbasins were filled halfway with water and left uncovered to obtain natural quantities of eggs.

To measure the efficacy of the chlorine bleach-detergent 5:1 mixture as a means of destroying eggs, a nine-step procedure was defined. In the first series of four trials, all nine steps were performed. In the second series of four trials, step #6 (5 min of scrubbing with a brush) was omitted. The steps...
were 1) empty the water from the washbasin, without moistening the eggs; 2) count the eggs on the wall using a handheld magnifying glass and a mechanical counter; 3) mix five tablespoons of chlorine bleach with one heaping tablespoon of detergent for every 0.27 m² of surface area of wall; 4) apply the mixture to the walls of the washbasin with a cellulose sponge; 5) wait 10 min; 6) scrub with a brush with plastic bristles for 5 min; 7) rinse the walls of the washbasin with tap water; 8) fill the washbasin with water and cover it with a tight-fitting screened cap; and 9) count the number of living larvae in the washbasin after 72 hr.

An even tablespoon of chlorine bleach is equivalent to 6.5 ml and a heaping tablespoon of detergent weighs 17 g. Due to the variety of washbasin sizes, larger washbasins require more of the mixture. Since the chlorine bleach-detergent 5:1 mixture needs to be spread or dabbed onto the walls (Spanish: untar) to destroy the eggs, the new procedure for removing eggs was named La Untadita, which literally means little dab.

To examine whether La Untadita resulted in inhibition of new oviposition by female mosquitoes in the days after its application, nine treated (four unmatched and five matched) and five control washbasins were located. The control washbasins were matched with treated washbasins by size and location (one block away in the same neighborhood). For the treated washbasins, La Untadita was applied, and the householder was instructed not to clean the washbasin until further notice. For the untreated washbasins, the householder was instructed to clean the washbasin once in her usual way, and then not to clean until further notice. The walls of the washbasins were checked daily with a magnifying glass until mosquito eggs were detectable.

RESULTS

The time-mortality curves for detergent and chlorine bleach are shown in Figures 1 and 2, respectively. Each data point represents the average of three replicates. In all assays the percent mortality in controls exposed only to tap water was less than 5% by the end of the experiment. Estimates of the different time periods required to reach 50% mortality in larvae and pupae exposed to different concentrations of detergent and chlorine bleach are summarized in Table 1. Each time estimate reported in the table represents the mean of three separate estimates read from the cumulative mortality graph at the 50% level, drawn for each of three replicates. The range of each 50% mortality value in the three replicates is also reported. The major findings of these assays were 1) that exposure to different dilutions of detergent resulted in 50% mortality much more rapidly than exposure to diluted chlorine bleach, 2) that pupae demonstrated greater resistance to the effects of detergent and chlorine bleach than larvae, and 3) that a longer period of time was required to reach 50% mortality when larvae and pupae were exposed to lower doses of detergent or chlorine bleach.

In the assays in which undiluted chlorine bleach was applied directly to the eggs, the bleach completely dissolved the eggs in 10–12 min. In the assays to measure the efficacy of diluted chlorine bleach on eggs, no eggs hatched either while submerged in the water containing any one of the bleach concentrations after 48 hr of exposure, or when subsequently transferred to fresh water. In eggs exposed to the diluted detergent, none hatched during the 48-hr period that they were exposed to any one of the detergent concentrations used, but 1–2% of the eggs hatched when transferred to fresh
FIGURE 2. Cumulative mortality of *Aedes aegypti* third and fourth instar larvae exposed to different concentrations of chlorine bleach. Each curve represents the mean ± SE of three replicates.

![Cumulative mortality graph](image)

**Table 1**

Estimated time required to reach 50% mortality in third and fourth instar larvae and pupae of *Aedes aegypti* exposed to different concentrations of detergent and chlorine bleach*

<table>
<thead>
<tr>
<th></th>
<th>Detergent</th>
<th>Chlorine bleach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 g/L</td>
<td>15 g/L</td>
</tr>
<tr>
<td>3rd/4th instar larvae</td>
<td>Mean</td>
<td>3.6 hr</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>3.4–3.9 hr</td>
</tr>
<tr>
<td>Pupae</td>
<td>Mean</td>
<td>89 min</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>78–96 min</td>
</tr>
</tbody>
</table>

* Values are the mean and range of three replicates.
† Represents mean of two replicates; 50% mortality was never reached in the third replicate.

Water. More than 70% of the eggs in the untreated control tray had hatched by the end of each experiment (71–96%).

The effect of *La Untadita* on eggs in washbasins is summarized in Table 2. A total of 99–100% of the eggs were eliminated, as shown by the number of surviving larvae after 74 hr when all nine steps were carried out. When the step of scrubbing the walls with the brush was omitted, 98–100% of the eggs were eliminated. This indicates that omitting the step of scrubbing did not decrease the efficacy of the method.

Trials to assess the potential for inhibition of subsequent oviposition by female mosquitoes in the days after cleaning with the bleach-detergent mixture showed that eggs first appeared in an average of 11.1 days (SD = 5.8) after application of the new method. In two of the nine treated washbasins, eggs appeared within one week. The five untreated washbasins remained free of eggs for an average of 6.2 days (SD = 3.3) after being cleaned, with eggs appearing in three of the five washbasins within one week.

**Discussion**

Effective control of *Aedes aegypti* remains elusive. One response in the face of limited options for control has been an emphasis on community participation in the physical control of larval container habitats. A frequent assumption has been that the behaviors to be promoted at the community level are well-defined. Little is known, however, regarding the effect of commonly used cleaning methods, including...
household chemicals, on the immature forms of *Ae. aegypti* in containers used for water storage within the household. It is well established that housewives use chlorine bleach and detergent to clean washbasins and drums, yet this cleaning is carried out not to eliminate mosquito eggs above the water line and larvae and pupae in the water, but rather to remove the green algae that grow below the water line and to maintain the water used for washing clear and free of debris.

The decision to focus on the elimination of eggs, and to apply *La Untadita* weekly was based on the following considerations. First, many years of concentrating on larvae had not resulted in their elimination, and householders reported being discouraged by seeing larvae appear almost as soon as they refilled their washbasins after cleaning them. Second, *Ae. aegypti* requires 7–14 days to complete its life cycle. Cleaning at least every seven days will therefore almost always prevent development of adult mosquitoes. Third, most householders already clean their washbasin at least once a week. Finally, while our data indicate that the application of *La Untadita* has some inhibitory effect on subsequent oviposition, the latter still took place in two washbasins within one week, making us hesitant to recommend that the method be applied less frequently than once a week.

The ovicidal effect of commercial chlorine bleach and its rapid action, as well as the rapid larvicidal effect of detergent, are promising findings. The chemical processes that occur during the destruction of eggs, larvae, and pupae were not addressed in this report.

While chlorine bleach and detergent are each eventually efficacious control agents of immature forms of *Ae. aegypti*, these results indicate that their use in isolation may not represent an effective method of control. When used by housewives to clean washbasins and drums, chlorine bleach and/or detergent are either sprayed separately on the walls, then rinsed off immediately, or added directly to the water. The effect of these chemicals on eggs, larvae, and pupae may thus disappear completely due to excessive dilution. When sprayed on the wall, they typically do not adhere for a long enough time for their effect to be seen, and complete coverage of the wall is not insured.

The logic behind creating a mixture of chlorine bleach and detergent and a procedure for applying it was two-fold. First, the mixture allows the active agents in chlorine bleach and detergent to come into direct contact with the mosquito eggs instead of being diluted in the water. Second, because of its viscosity the mixture can adhere to the walls of the washbasin for a longer period of time, allowing the full ovicidal effect of the agents to be seen. Finally, the consistency of the 5:1 mixture is neither too liquid nor too solid, allowing the householder to apply a uniform coat of it to the wall of the washbasin.

*La Untadita* has a number of significant advantages over previous recommendations for cleaning and other chemical and biological control agents. 1) The method is feasible for householders to carry out because the materials are of low cost and easily obtainable. It rationalizes the use of materials already included in the cleaning routine, and does not represent a drastic alteration in pre-existing behaviors. 2) The method is sustainable because it does not require that any materials be imported, nor does it require the supervision of medical entomologists or other specialists. 3) Under controlled conditions, the method is efficacious because it has been shown to result in almost complete destruction of *Ae. aegypti* eggs. It is not, however, efficacious against the eggs of mosquito species that oviposit directly into the water such as *Culex quinquefasciatus*.

While efficacious under controlled conditions, this paper does not address the effectiveness of the method in the hands of householders. Threats to the effectiveness of the method include lack of uniform application of the chlorine bleach-detergent mixture over the entire surface of the washbasin where eggs are located, rinsing the mixture off before it has had time to destroy the eggs, failure to clean the washbasin at least once per week, and inability to purchase chlorine bleach or detergent due to lack of money. The effectiveness of *La Untadita* was addressed in a subsequent field trial in El Progreso conducted between September 1995 and November 1996. The results of this field trial are still being analyzed.

Other control methods such as cyclopoid copepods, juvenile turtles, or larvicides require a supply system either through a vertical program or a well-developed community-based program with volunteers manning supply posts. Community participation in such a context becomes secondary to the adoption of the new technology and accordingly less autonomous. For this reason, we believe it is important to choose control methods that are based on practices that already exist in the community. Field experience in this project has demonstrated that people are familiar with and value greatly the cleaning properties of chlorine bleach or detergent, making it easier to convince them of their efficacy in eliminating the eggs of *Ae. aegypti*.

This method is proposed as only one component in an integrated community-based strategy for *Ae. aegypti*. It will not be effective for washbasins and drums that are either not in use or are cleaned infrequently. The latter may be candidates for the application of other chemical or biological control agents such as copepods or for some type of lid. In addition, it is not appropriate for containers that are not routinely cleaned by householders such as tires.

Acknowledgments: We thank the following persons who in various ways have contributed to this work: the personnel of the Integrated Dengue Control Project in El Progreso, Honduras; Luis Rivera (Ministry of Public Health, Division of Vector-Borne Diseases [MSP-DETV], Tegucigalpa, Honduras); Marco F. Suarez (Universidad del Valle, Cali, Colombia); and Gary G. Clark (San Juan Laboratories. 

<table>
<thead>
<tr>
<th>Washbasin</th>
<th>Initial number of eggs detected after 72 hr developing into larvae</th>
<th>Percent of eggs not developing into larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,342</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>961</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>591</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>1,135</td>
<td>0</td>
</tr>
<tr>
<td>Applying mixture and scrubbing with brush (nine steps)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2,408</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1,260</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2,129</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1,460</td>
<td>20</td>
</tr>
</tbody>
</table>

**TABLE 2**

Efficacy of two methods of applying chlorine bleach-detergent 5:1 mixture in destroying eggs of *Aedes aegypti* deposited on walls of washbasins

**La Untadita** has a number of significant advantages over previous recommendations for cleaning and other chemical and biological control agents. 1) The method is feasible for householders to carry out because the materials are of low cost and easily obtainable. It rationalizes the use of materials already included in the cleaning routine, and does not represent a drastic alteration in pre-existing behaviors. 2) The method is sustainable because it does not require that any materials be imported, nor does it require the supervision of medical entomologists or other specialists. 3) Under controlled conditions, the method is efficacious because it has been shown to result in almost complete destruction of *Ae. aegypti* eggs. It is not, however, efficacious against the eggs of mosquito species that oviposit directly into the water such as *Culex quinquefasciatus*.

While efficacious under controlled conditions, this paper does not address the effectiveness of the method in the hands of householders. Threats to the effectiveness of the method include lack of uniform application of the chlorine bleach-detergent mixture over the entire surface of the washbasin where eggs are located, rinsing the mixture off before it has had time to destroy the eggs, failure to clean the washbasin at least once per week, and inability to purchase chlorine bleach or detergent due to lack of money. The effectiveness of *La Untadita* was addressed in a subsequent field trial in El Progreso conducted between September 1995 and November 1996. The results of this field trial are still being analyzed.

Other control methods such as cyclopoid copepods, juvenile turtles, or larvicides require a supply system either through a vertical program or a well-developed community-based program with volunteers manning supply posts. Community participation in such a context becomes secondary to the adoption of the new technology and accordingly less autonomous. For this reason, we believe it is important to choose control methods that are based on practices that already exist in the community. Field experience in this project has demonstrated that people are familiar with and value greatly the cleaning properties of chlorine bleach or detergent, making it easier to convince them of their efficacy in eliminating the eggs of *Ae. aegypti*.

This method is proposed as only one component in an integrated community-based strategy for *Ae. aegypti*. It will not be effective for washbasins and drums that are either not in use or are cleaned infrequently. The latter may be candidates for the application of other chemical or biological control agents such as copepods or for some type of lid. In addition, it is not appropriate for containers that are not routinely cleaned by householders such as tires.

Acknowledgments: We thank the following persons who in various ways have contributed to this work: the personnel of the Integrated Dengue Control Project in El Progreso, Honduras; Luis Rivera (Ministry of Public Health, Division of Vector-Borne Diseases [MSP-DETV], Tegucigalpa, Honduras); Marco F. Suarez (Universidad del Valle, Cali, Colombia); and Gary G. Clark (San Juan Laboratories.
Centers for Disease Control and Prevention, San Juan, PR), all of whom have generously provided on-going technical advice in medical entomology; Scott B. Halstead (Health Sciences Division, The Rockefeller Foundation, New York, NY); Enrique Gil (MSP-DETV); and Mark Nichter (University of Arizona, Tucson, AZ), who have provided both administrative and technical support at different points in the project; and finally the residents of the study neighborhoods who welcomed us into their homes on countless occasions.

Financial support: Funds for this research were provided by the Rockefeller Foundation, Health Sciences Division, through the Integrated Dengue Control Project of the Ministry of Public Health of Honduras.

Authors’ addresses: Catalina Sherman, Eduardo A. Fernandez, and Reina C. Lozano, Proyecto Control Integral de Dengue, Apartado Postal 15, El Progreso, Yoro, Honduras. Adeline S. Chan, Elli Leontsini, and Peter J. Winch, Department of International Health, The Johns Hopkins University, School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore MD 21205.


REFERENCES