Journal of the American Mosquito Control Association, 20(1):6–11, 2004

EVALUATION OF SURVEILLANCE DEVICES FOR MONITORING *AEDES AEGYPTI* IN AN URBAN AREA OF NORTHEASTERN PERU[1]

GEORGE B. SCHOELER,[2] SONYA S. SCHLEICH,[3] STEPHEN A. MANWEILER[4] AND VICTOR LOPEZ SIFUENTES[2]

ABSTRACT. In this study, we assessed the efficacy of the American Biophysics Corporation Standard Professional (ABC-PRO) light trap, the Omni-Directional Fay–Prince trap (with and without CO_2), and the Centers for Disease Control and Prevention Wilton trap as a means of evaluating populations of adult *Aedes aegypti* in an urban area of northeastern Peru. Efficacies of collections from each of the trap types were compared to backpack-aspirator collections and human-landing collections. Collections were conducted twice daily, 3 days per week, for 27 wk from July 2001 to July 2002. Backpack-aspirator collections yielded significantly more mosquitoes (1,764) than any of the other collecting methods with a mean of 21.80 mosquitoes collected per sampling period. This method was less specific for *Ae. aegypti* than were human-landing collections because only 28.3% of mosquitoes collected with backpack aspirators were *Ae. aegypti.* Human-landing collections yielded only 23% (554/2,411) of the total mosquitoes collected. However, more than 80% (445/554) of the mosquitoes collected by this method were *Ae. aegypti.* None of the trapping devices evaluated collected mosquitoes, specifically *Ae. aegypti,* as effectively as backpack-aspirator or human-landing collections. The ABC-PRO trap, which was the most effective device in collecting mosquitoes, particularly *Ae. aegypti,* collected less than 2% of the total mosquitoes (mean of 0.12 mosquitoes/sampling period), and less than 3% of total *Ae. aegypti* (mean of 0.11 *Ae. aegypti*/sampling period). We conclude that none of the trap devices evaluated in this study is an acceptable alternative to backpack-aspirator or human-landing collections for monitoring populations of adult *Ae. aegypti* in Peru.

KEY WORDS *Aedes aegypti,* traps, surveillance devices

INTRODUCTION

Historically, *Aedes aegypti* (L.) is the primary vector responsible for the transmission of viruses that cause human dengue and dengue hemorrhagic fever worldwide (Womack 1993). A peridomestic species associated with human dwellings, this vector is especially abundant in urban areas and feeds primarily in the early mornings and late afternoons. Female *Ae. aegypti* feed preferentially on humans and typically reside inside homes in darkly lit closets, cabinets, and cupboards. This species breeds in artificial containers such as cans, jars, urns, or rainwater containers. Adults reportedly fly only a few hundred yards from breeding sites (Womack 1993).

To assess the effectiveness of any control effort directed against dengue mosquito vectors, it is vital to accurately and precisely sample the vector population. Such determinations must be made before and after control strategies have been conducted, if one hopes to make any reliable statement on the effectiveness or noneffectiveness of the control methods used. In addition, effective vector population sampling is necessary when attempting to predict dengue outbreaks and determine when and where to apply control measures to prevent and suppress such outbreaks.

Populations of *Ae. aegypti* generally are monitored by measuring larval or pupal densities by using Breteau, house, or container indices (Service 1993, Tun-Lin et al. 1996). Although indices of immature *Ae. aegypti* are useful, surveillance of adult populations is often necessary to determine the threat of transmission of dengue and dengue hemorrhagic fever and to assist in determining when and where mosquito control measures should be applied.

Historically, the simplest and most effective sampling method for adult dengue mosquito vectors has been the direct aspiration of mosquitoes from human collectors, known as human-landing collections (Service 1993, Focks et al. 2000). Although effective in determining the exact anthropophilic species composition, human attack rate, and transmission dynamics, this method is both labor intensive and exposes the collectors to a degree of risk to disease infection, especially for those vector-borne diseases that have no current effective prophylactic drug or vaccine, such as dengue. Another labor-intensive dengue vector sampling method is known as resting collections or total premise aspiration. This method requires collectors to use either hand held collection equipment (nets, flashlights, and battery-powered handheld aspirators) or specially designed backpack aspirators (Service 1993).

Various traps and trapping designs for adult mosquitoes have been used with different degrees of effectiveness in sampling mosquito populations throughout the world (Service 1993). Light traps,

[1] The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the Departments of the Army or Navy, or the Department of Defense at large.

[2] Entomology Department, U.S. Naval Medical Research Center Detachment, APO AA 34031.

[3] Department of Entomology, Walter Reed Army Institute of Research, 503 Robert Grant Avenue, Silver Spring, MD 20910.

[4] Metropolitan Mosquito Control District, 2099 University Avenue W, St. Paul, MN 55104.

such as the commonly used Centers for Disease Control and Prevention (CDC) miniature light trap and the New Jersey light trap, are virtually ineffective in sampling for day-biting mosquitoes (Service 1993). A variety of other surveillance devices have been developed for surveillance of adult *Ae. aegypti.* These trap devices include ovitraps (Reiter et al. 1991, Rawlins et al. 1998), resting boxes (Edman et al. 1997, Kittayapong et al. 1997), backpack aspiration (Service 1993), and a variety of trapping devices specifically designed for surveillance of adult *Ae. aegypti* (Fay and Prince 1970, Jensen et al. 1994). These trapping devices, utilized with and without attractants, have shown varying success in sampling populations of adult *Ae. aegypti* (Jensen et al. 1994, Canyon and Hii 1997).

The objective of this study was to evaluate the efficacy of several traps as a means of monitoring populations of adult *Ae. aegypti* in an urban area of northeastern Peru. Traps that were evaluated included the Omni-Directional Fay–Prince trap (evaluated with and without CO_2 as an attractant), the American Biophysics Corporation Standard Professional (ABC-PRO) light trap (baited with CO_2), and the CDC Wilton trap. The efficacy of collections from each of these trapping devices was compared to human-landing and backpack-aspirator collections. The goal of the study was to determine if the trapping devices evaluated would collect high numbers of *Ae. aegypti,* and few non-*Aedes* mosquitoes, when compared to human-landing and backpack-aspirator collections.

MATERIALS AND METHODS

Study site: This study was conducted in Iquitos, a city located along the banks of the Amazon River in the Department of Loreto, northeastern Peru. The city of Iquitos currently reports a population of approximately 340,000. The climate of the study area is tropical, with an average daily temperature of 25°C and an annual average precipitation of 2.7 m. The population is predominately mixed Spanish and Amerindian, and the major occupations are agriculture, fishing, small business, military, and tourism. Six houses were chosen in Villa Punchana, a sector of the city of Iquitos where high populations of *Ae. aegypti* have historically been reported.

Traps evaluated: Traps evaluated in this study included the ABC-PRO light trap, the Omni-Directional Fay–Prince trap (1 trap baited with dry ice and 1 trap operated without dry ice bait), and the CDC Wilton trap. Backpack-aspirator and human-landing collection were used as the reference against which the efficacy of the other traps was compared.

The ABC-PRO trap (Clarke Mosquito Control Products, Roselle, IL) is similar to the CDC miniature light trap, and consists of a rain lid, lightbulb, fan (powered by 6-V batteries), electronic modules, and an insulated 2-liter container, assembled directly to the top of the trap, with a built-in manifold to provide CO_2 at a continuous rate of approximately 500 ml/min.

The Omni-Directional Fay–Prince trap (model 112, John W. Hock Company, Gainesville, FL) was developed in 1970 (Fay and Prince 1970). This trap was designed specifically to monitor populations of adult *Ae. aegypti* and *Aedes albopictus* Skuze. The original unidirectional trap was later redesigned by mounting 2 Fay–Prince traps back-to-back to more efficiently collect *Aedes,* and therefore was named the Omni-Directional trap. The Omni-Directional Fay–Prince trap can incorporate attractants, such as CO_2 and octenol, to increase trap capture rates (Kline 1994).

The CDC Wilton trap (model 1912, John W. Hock Company) was developed as a collaborative effort of the CDC and the New Orleans Mosquito Control Board. This trap was designed to collect *Ae. aegypti* and *Culex quinquefasciatus* Say. The trap's attractiveness is due to the shiny black appearance of the trap body (Wilton 1985). A screened collection cup precedes the suction fan and is recessed into the upper portion of the trap, thereby preventing damage to mosquito specimens.

The backpack aspirator (model 1412, John W. Hock Company) has been widely used to collect adult mosquitoes resting indoors (Rawlins et al. 1998). In this study, the backpack aspirator was used for approximately 15–30 min per house during each 2-h trapping period. Human-landing collections were conducted from 0800 to 1000 h and from 1400 to 1600 h in 1 of the residences on each trapping day. Mosquitoes were collected into glass vials by using mouth aspirators as they landed on both legs of the collector. The study protocol was approved by institutional review boards at the Naval Medical Research Center (protocol DoD 31565) in compliance with all federal regulations governing the protection of human subjects.

Study design: Field tests were conducted in 6 premises (houses) in Villa Punchana in the city of Iquitos. The 6 houses were in similar ecological habitats, of similar design, and were a minimum of 500 m apart. A different trapping device or trapping method was conducted or placed in each house selected for the study. Each type of trapping device (the Omni-Directional Fay–Prince trap [with and without CO_2], the CDC Wilton trap, and ABC-PRO trap) was evaluated in a separate houses, and human-landing collection and backpack-aspirator collections were conducted in 2 other houses. Because *Ae. aegypti,* the primary vector of dengue worldwide, is active during daylight hours (Gubler 1997), all mosquito sampling was performed during daylight hours. Traps, human-landing collections, and backpack-aspirator collections were conducted from 0800 to 1000 h and again from 1600 to 1800 h, 3 days per week (every other day), every 2 wk, for a total of 27 wk, from July 2001 to July 2002. Each trap type, human-landing collections, and

Table 1. Total number and mean number per trap sampling period (and standard error of the mean [SEM]) of female mosquitoes and female *Aedes aegypti* collected using 5 collection methods from 6 houses in Iquitos, Peru, 2001–2002. Groups followed by the same lowercase letter are not significantly different ($P > 0.05$)

Type of collection[1]	No. trap periods	Total mosquitoes		Total Ae. aegypti	
		No. (% of total)	Mean/trap (SEM)	No. (% *Ae.aegypti*)[2]	Mean/trap (SEM)
Backpack-aspirator	81	1,764 (73.2)	21.80 (2.90)a	500 (28.3)	6.17 (0.98)a
Human-landing	81	554 (23.0)	6.84 (1.26)b	445 (80.3)	5.50 (0.04)a
ABC-PRO-trap	81	42 (1.7)	0.52 (0.12)c	26 (61.9)	0.32 (0.11)b
Omni-Directional Fay Prince	81	21 (0.9)	0.26 (0.08)c	9 (42.9)	0.11 (0.04)bc
CDC Wilton	81	19 (0.8)	0.23 (0.05)c	4 (21.1)	0.05 (0.02)bc
Omni-Directional Fay Prince	81	11 (0.5)	0.14 (0.06)c	2 (18.2)	0.02 (0.02)c
Total		2,411		986	

[1] ABC-PRO, American Biophysics Corporation Standard Professional; CDC, Centers for Disease Control and Prevention.
[2] Percentage of *Ae. aegypti* of the total caught from each collecting method.

backpack-aspirator collections were rotated each trap session between the 6 houses to control for any site variation.

Traps were placed 1 m above the ground in the corner of a room in each house during each trapping session. The ABC-PRO trap and 1 of the Omni-Directional Fay–Prince traps were baited with 2 kg of dry ice each time traps were set. The backpack-aspirator collection was done by aspirating the entire premise (house) every hour for 15 min, both during the morning and afternoon sampling periods. The human-landing collections involved a human volunteer aspirating all mosquitoes landing on both exposed legs, from the knee to the ankle, by using a mouth aspirator. Human-landing collections were conducted for 55 min, with a 5-min rest period, every hour from 0800 to 1000 h and again from 1600 to 1800 h. All mosquitoes collected were placed in separate, labeled pint-sized cartons and were transported back to the laboratory where they were identified and counted.

Data analysis: The number of female mosquitoes and number of female *Ae. aegypti* captured each day (sample date) by each trap design or sampling method for all sampling dates were tallied. For each sampling method or trap design the number of sample dates when mosquitoes were captured was compared to the number of dates when mosquitoes were not captured. These proportions were presented as percentages of sample dates and each sample method or trap design was compared by chi-square analyses (Steel et al. 1997). Significance was indicated by a P-value equal to or less than 0.05.

The mean mosquito capture for each 3 consecutive day sample period was determined and means were used as raw data to normalize the data distributions (via the central limit theorem) (Steel et al. 1997). Ninety-five percent confidence limits were determined by using a t-statistic (Steel et al. 1997) and separate variances for each sample method or trap design. Overlap of the 95% confidence limits indicated a lack of statistical significance.

For each of the sampling methods or trap designs, the proportion of captured female mosquitoes that were *Ae. aegypti* was calculated. The total number of female mosquitoes and female *Ae. aegypti* collected on all sample dates, when at least 1 mosquito was captured, was used to calculate the proportion of mosquitoes collected that were *Ae. aegypti.* Ninety-five percent confidence limits were determined by using a Z-statistic (Steel et al. 1997). Overlap of the 95% confidence limits indicated a lack of statistical significance.

RESULTS

A cumulative total of 2,411 adult mosquitoes was collected by all trap designs or collection methods over the course of the study. Of the total mosquitoes collected, more than 73% (1,764) were collected with the backpack aspirator, followed by 23% (554) collected by human-landing collections, with 1.7% (42), 0.9% (21), 0.8% (19), and 0.5% (11) collected by the ABC-PRO, Omni-Directional Fay–Prince with CO_2, CDC Wilton, and Omni-Directional Fay–Prince without CO_2 traps, respectively (Table 1). The mean number of mosquitoes collected per sampling period was significantly higher (21.80 mosquitoes/sampling period) for backpack-aspirator collections than for any of the other collecting methods or trap types (Table 1). Human-landing collections yielded the 2nd highest mean number of mosquitoes per collecting period (6.84), significantly greater than the traps evaluated, yet significantly less than backpack-aspirator collections (Table 1). The mean number of mosquitoes collected in each of the trap types was significantly less than for backpack-aspirator or human-landing collections. No significant differences were seen between mean numbers of mosquitoes collected among the trap types.

Of the total number of mosquitoes collected, 986 (40.9%) were *Ae. aegypti* (Table 1). The 1,425 remaining mosquitoes (59.1%) represented 32 species of 9 genera that were collected during the study. We focused upon *Ae. aegypti* because the goal of these comparisons was to determine if 1 or more

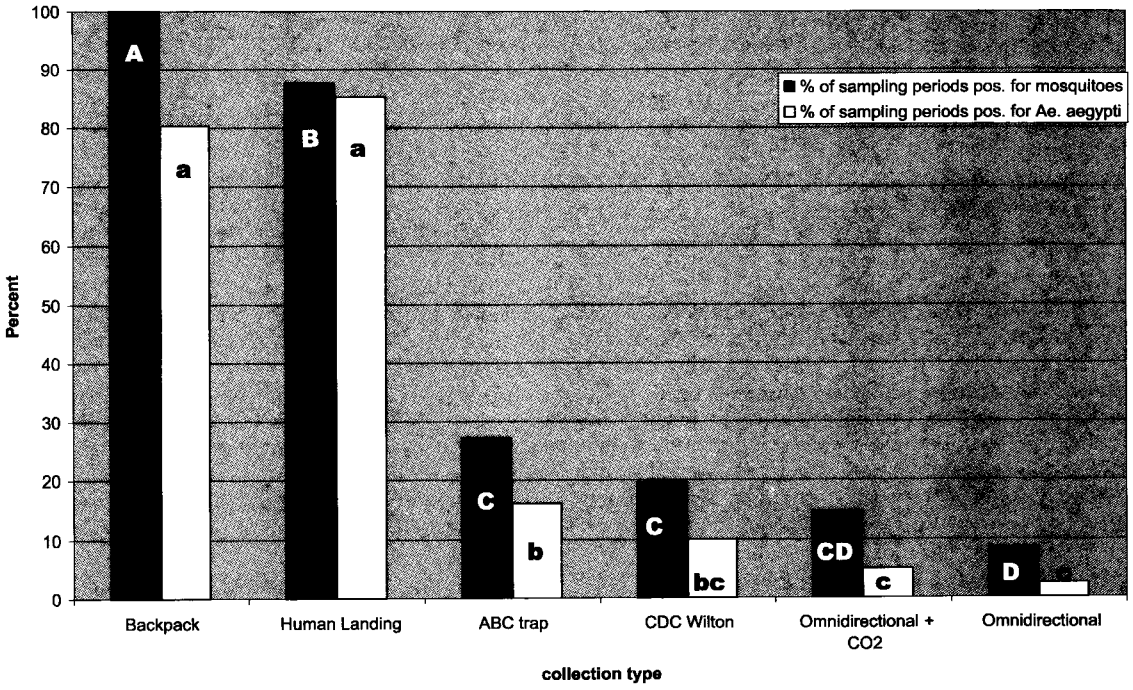

Fig. 1. Percent of 81 sampling periods positive for mosquitoes and 1 or more *Aedes aegypti* from collections conducted in Iquitos, Peru, 2001–2002. Collections methods included backpack-aspirator collections (backpack), human-landing collections (human landing), American Biophysics Corporation trap (+ CO_2) (ABC trap), CDC Wilton trap (CDC Wilton), Omni-Directional Fay–Prince trap + CO_2 (Omni-directional + CO_2), and Omni-Directional Fay–Prince trap (Omni-directional). Groups with the same uppercase letter are not significantly different and groups with the same lowercase letters are not significantly different ($P > 0.05$).

of the collecting methods captured *Ae. aegypti* effectively enough for use in a dengue risk reduction program. Therefore, statistics for the other species and genera are not presented in this paper.

Human-landing collections were most specific for *Ae. aegypti*; more than 80% (445/554) of mosquitoes collected by this method were *Ae. aegypti.* In contrast, only 28.3% (500/1,764) of mosquitoes collected by backpack-aspirator collections were *Ae. aegypti* (Table 1). Although the traps collected few mosquitoes when compared to backpack-aspirator or human-landing collections, more than 61% (26/42) of mosquitoes collected in the ABC-PRO trap were *Ae. aegypti,* followed by more than 42% (9/21), 21% (4/19), and 18.2% (2/11) collected in the omni-directional Fay–Prince with CO_2, CDC Wilton, and Omni-Directional Fay–Prince without CO_2 traps, respectively (Table 1).

The mean numbers of *Ae. aegypti* collected per sampling period by the backpack-aspirator and human-landing collections (6.17 and 5.50), although not significantly different between the 2, were significantly higher than that of any of the trap devices evaluated. The mean number of *Ae. aegypti* collected per sampling period by the ABC-PRO, Omni-Directional Fay–Prince with CO_2, and CDC Wilton traps did not differ significantly (although again, the mean number of *Ae. aegypti* collected by these traps was significantly lower than backpack-aspirator or human-landing collections; Table 1). The Omni-Directional Fay–Prince trap without CO_2 collected significantly fewer *Ae. aegypti* per sampling period than any of the other trap types or sampling methods.

The most effective sampling method for collecting mosquitoes was the backpack-aspirator collection; mosquitoes were collected during each sampling period (100% of sampling periods) utilizing this method (Fig. 1). Human-landing collections yielded mosquitoes from almost 90% of the sampling periods, which was significantly lower than backpack-aspirator collections but significantly higher than the trapping devices. The ABC-PRO trap collected mosquitoes from less than 30% of the sampling periods, followed by the CDC Wilton, Omni-Directional Fay–Prince trap with CO_2, and the Omni-Directional Fay–Prince without CO_2, which collected mosquitoes from less than 20% of the sampling periods (Fig. 1).

Human-landing and backpack-aspirator collections also collected *Ae. aegypti* significantly more often (>80% of sampling periods) than any of the trapping devices. No significant differences were observed between human-landing and backpack-aspirator collections ($P > 0.05$). In contrast, each of the trapping devices collected *Ae. aegypti* from

fewer than 20% of the sampling periods (Fig. 1). These results, combined with the total numbers of mosquitoes and *Ae. aegypti* collected, and mean numbers collected per trapping period, demonstrate that backpack-aspirator and human-landing collection methods are more effective methods for collecting mosquitoes and *Ae. aegypti* than any of the trapping devices evaluated.

DISCUSSION

The results clearly demonstrate that none of the trapping devices collected mosquitoes as efficiently as backpack-aspirator or human-landing collections. Collections utilizing backpack aspirators yielded mosquitoes during every collecting period (100%), whereas human-landing collections yielded mosquitoes from approximately 87% of the collecting periods (Fig. 1). In contrast, the trapping devices collected mosquitoes during less than 30% of the sampling periods. During the trapping periods in which mosquitoes were collected, more than 85% of human-landing collection periods yielded *Ae. aegypti,* whereas backpack-aspirator collections yielded *Ae. aegypti* in more than 80% of the collecting periods. Of the trapping devices, the ABC-PRO trap collected *Ae. aegypti* from only 16% of the trapping periods when mosquitoes were collected, and this was significantly greater than the other traps (Fig. 1).

More total mosquitoes were collected by using the backpack aspirator, but a higher percentage of the total mosquitoes that were *Ae. aegypti* was collected with human-landing collections. Specifically, of the 1,764 mosquitoes collected with the backpack aspirator, 500 (28.3%) of the mosquitoes were *Ae. aegypti.* In contrast, 554 mosquitoes were collected by human-landing collections, and 445 (80.3%) of these were *Ae. aegypti.* Additionally, backpack-aspirator collections yielded a mean of 21.80 mosquitoes per collecting period, significantly more than any of the other sampling methods (Table 1).

None of the trapping devices performed well in collecting mosquitoes, when compared to human-landing or backpack-aspirator collections. The ABC-PRO trap collected the most total mosquitoes of the traps (42) but significantly fewer mosquitoes than human-landing or backpack-aspirator collections. The least effective trapping device was the Omni-Directional Fay–Prince trap (without CO_2), because only 11 mosquitoes were collected in this trap when operated without CO_2, and only 2 of the mosquitoes collected were *Ae. aegypti.*

Although the Omni-Directional Fay–Prince and CDC Wilton traps were developed as tools for the collection of *Ae. aegypti* (Fay and Prince 1970), these traps collected significantly fewer total mosquitoes or *Ae. aegypti* than did human-landing or backpack-aspirator collections. In fact, the ABC-PRO trap, a trap not developed specifically for surveillance of *Ae. aegypti,* performed better in collecting any mosquitoes, including *Ae. aegypti,* than those traps developed specifically for day-biting *Aedes* spp.

Our results differ somewhat from results reported by Jensen et al. (1994) in which they reported no significant differences between mean numbers of *Ae. aegypti* collected in CDC (similar to the ABC-PRO) and Omni-Directional traps. Our results demonstrate that the ABC-PRO trap was the most effective, and the Omni-Directional trap was least effective, at collecting any mosquitoes, including *Ae. aegypti,* among any of the traps evaluated. During their study, conducted over an 8-day period in a tire yard in northern Florida, much higher numbers of *Ae. aegypti* were collected in the traps evaluated than those collected during our study. This may be due to the study locations, because fewer mosquitoes may be encountered inside homes in urban areas, such as the area where our study was conducted, than in a more open, outside area such as a tire yard. Canyon and Hii (1997) found that a Bi-Directional Fay–Prince trap (another surveillance device designed specifically for *Aedes*) baited with dry ice captured a mean of 1.8 *Ae. aegypti* over a 14-h period, compared to means of 1.7 and 3.6 *Ae. aegypti* obtained during 10-min morning and evening human-landing collections, respectively. Examination of these data suggests that use of the Fay–Prince trap is significantly less efficient than human-landing collections.

Our results demonstrate that these trapping devices are not effective for monitoring populations of *Ae. aegypti* in this area of Peru. The most effective trap device evaluated, the ABC-PRO trap, collected less than 2% of the total mosquitoes and less than 3% of *Ae. aegypti* obtained during this study. Human-landing collections were the most specific method for collecting *Ae. aegypti* during our study. Although this method obtained less than 32% of the number of mosquitoes collected by the backpack aspirator, a large proportion (>80%) of the mosquitoes collected with human bait were *Ae. aegypti.* Unfortunately, ethical considerations in utilizing human-landing collections to monitor populations of *Ae. aegypti* in dengue endemic areas may preclude human-landing collections. Therefore, although less specific than human-landing collections, our results suggest that backpack-aspirator collections are the most effective method to monitor populations of *Ae. aegypti* in this region of South America.

ACKNOWLEDGMENTS

Funding for this project was provided by Work Unit Number (WUN) 6287A.870.U.B0003 of the Military Infectious Diseases Research Program, U.S. Army Medical Research and Materiel Command, Fort Detrick, MD.

REFERENCES CITED

Canyon DV, Hii JLK. 1997. Efficacy of carbon dioxide, 1-octen-3-ol, and lactic acid in modified Fay–Prince traps as compared to man-landing catch of *Aedes aegypti*. *J Am Mosq Control Assoc* 13:66–70.

Edman J, Kittayapong P, Linthicum K, Scott T. 1997. Attractant resting boxes for rapid collection and surveillance of *Aedes aegypti* (L.) inside houses. *J Am Mosq Control Assoc* 13:24–27.

Fay RW, Prince WH. 1970. A modified visual trap for *Aedes aegypti*. *Mosq News* 30:20–23.

Focks DA, Brenner RJ, Hayes J, Daniels E. 2000. Transmission thresholds for dengue in terms of *Aedes aegypti* pupae per person with discussion of their utility in source reduction efforts. *Am J Trop Med Hyg* 62:11–18.

Gubler DJ. 1997. Dengue and dengue hemorrhagic fever: its history and resurgence as a global public health problem. In: Gubler DJ, Kuno G, eds. *Dengue and dengue hemorrhagic fever* New York: CAB International. p 1–22.

Jensen T, Willis OR, Fukuda T, Barnard DR. 1994. Comparison of bi-directional Fay, omni-directional CDC, and duplex cone traps for sampling adult *Aedes albopictus* and *Aedes aegypti* in North Florida. *J Am Mosq Control Assoc* 10:74–78.

Kittayapong P, Linthicum KL, Edman JD, Scott TW. 1997. Further evaluation of indoor resting boxes for *Aedes aegypti* surveillance. *Dengue Bull* 21:74–78.

Kline DL. 1994. Olfactory attractants for mosquito surveillance and control: 1-octen-3-ol. *J Am Mosq Control Assoc* 10:280–287.

Rawlins SC, Martinez R, Wiltshire S, Legall G. 1998. A comparison of surveillance systems for the dengue vector *Aedes aegypti* in Port of Spain, Trinidad. *J Am Mosq Control Assoc* 7:131–136.

Reiter P, Amador MA, Colon N. 1991. Enhancement of the CDC ovitrap with hay infusions for daily monitoring of *Aedes aegypti* populations. *J Am Mosq Control Assoc* 7:52–55.

Service MW. 1993. *Mosquito ecology field sampling methods* 2nd ed. London: Elsevier Applied Science. 988 p.

Steel RGD, Torrie JH, Dickey DA. 1997. *Principles and procedures of statistics: a biometrical approach* New York: McGraw-Hill.

Tun-Lin W, Kay BH, Barnes A, Forsyth S. 1996. Critical examination of *Aedes aegypti* indices: correlation and abundance. *Am J Trop Med Hyg* 54:543–547.

Wilton D.P. 1985. Preliminary evaluation of a black cylinder suction trap for *Aedes aegypti* and *Culex quinquefasciatus* (Diptera: Culicidae). *J Med Entomol* 22: 113–114.

Womack M. 1993. The yellow fever mosquito, *Aedes aegypti*. *Wing Beats* 5(4):4.