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EVALUATION OF SELECTED TRAPS AS TOOLS FOR CONDUCTING SURVEILLANCE FOR ADULT *AEDES AEGYPTI* IN THAILAND[1]

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ABSTRACT. The efficacy of the omnidirectional Fay–Prince trap (ODFP), the Centers for Disease Control Wilton trap (WT), and sticky lures (SL) were assessed as a means of evaluating population densities of adult *Aedes aegypti* in Thailand. Human landing/biting (L/B) collection was used as the reference method. The L/B collection method was significantly more effective at capturing *Ae. aegypti* than any of the other methods, with 84% (1,072/1,272), 8.5% (108/1,272), 7.2% (92/1,272) and 0% (0/1,272) of mosquitoes collected by L/B collection, ODFP, WT, and SL, respectively. Overall, none of the traps evaluated in this study was demonstrated to be an acceptable alternative to L/B collection for surveillance of adult *Ae. aegypti* in Thailand.

KEY WORDS Traps, Thailand, surveillance, *Aedes aegypti*, mosquito

INTRODUCTION

Dengue and dengue hemorrhagic fever occur throughout the tropical and semitropical regions of the world (Gubler and Kuno 1997). *Aedes aegypti* (L.) is the primary vector of dengue, with *Ae. albopictus* Skuse serving as a secondary vector in certain areas. Populations of *Ae. aegypti* normally are monitored by assessing larval or pupal densities or both with the Breteau, house, or container indices (Service 1993, Tun-Lin et al. 1996). Although monitoring of abundance of immature *Ae. aegypti* is useful towards determining risk of dengue transmission, assessment of adult populations is considered a better indicator of risk to assist in determining when and where control methods should be applied. Surveillance for adult *Ae. aegypti* is more difficult than for many nocturnal- or crepuscular-biting mosquitoes. The widely used Centers for Disease Control (CDC) miniature light trap and New Jersey light trap are relatively ineffective against most day-biting mosquitoes (Service 1993); therefore, a variety of alternative trapping methods have been developed for use in surveillance programs for *Ae. aegypti*. These include use of ovitraps (Reiter et al. 1991, Rawlins et al. 1998), resting boxes (Edman et al. 1997, Kittayapong et al. 1997), back-pack aspiration (Service 1993), and a variety of traps specifically developed for *Ae. aegypti* (Fay and Prince 1970, Freier and Francy 1991, Jensen et al. 1994, Canyon and Hii 1997, Rawlins et al. 1998).

The objectives of this study were to evaluate the efficacy of several traps as a means of collecting adult *Ae. aegypti* in Thailand, and to provide a standard surveillance method that would selectively collect high numbers of *Ae. aegypti*.

MATERIALS AND METHODS

Traps evaluated: Traps evaluated in this study included the omnidirectional Fay–Prince trap (ODFP), 2) the CDC Wilton trap (WT), and a sticky lure (SL). Human landing/biting (L/B) collection was used as the reference against which the efficacy of the other traps was compared.

The ODFP (Model 112, John W. Hock Company, Gainesville, FL) was 1st developed in 1970 (Fay and Prince 1970). The trap was designed specifically for sampling adult *Ae. aegypti* and *Ae. albopictus*. The original unidirectional trap was later redesigned by mounting 2 Fay–Prince traps back-to-back (omni–directional) to increase trap capture rates. The ODFP can incorporate dry ice (CO_2) or octenol as attractants (Kline 1994).

The WT (Model 1912, John W. Hock Company) was a cooperative design effort of the CDC and the New Orleans Mosquito Control Board. The WT was designed to collect *Ae. aegypti* and *Culex quinquefasciatus* Say. The trap is attractive by virtue of its shiny black appearance. Mosquitoes are captured in a screened cup located at the top portion of the trap that precedes the suction fan, therefore avoiding damage to specimens.

The SL (AT948, Austech International Pty., Ltd., Spotswood, Victoria, Australia) used in this study consisted of an adhesive material applied to a red-colored cardboard background together with a proprietary mosquito attractant (Bangs et al. 2001). The device previously has been tested in Indonesia (Bangs et al. 2001) and East Timor (Bruce Russell, unpublished data).

Study design: The study consisted of a modified Latin square. Each of the 4 collection methods (L/B collection, ODFP, WT, and SL) were evaluated in 4 houses daily over a 4-day period (16 trap days). Traps were randomly rotated among the 4 houses until each trap had been tested in each house. Two separate trials were conducted, for a total of 32 trap days. A total of 16 different houses were used in each trial (32 total houses). The 1st trial was conducted on June 12, 14, 19, and 21, 2001, and the 2nd trial was on June 13, 20, 26, and 28, 2001.

[1] The views of the authors do not purport to represent the position of the Department of the Army or the Department of Defense.

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Table 1. Total adult *Aedes aegypti* collected with 4 different trapping methods in Thailand.

Type of collection[1]	*Ae. aegypti* collected			Age grade (%)			
	Trap days	Total collected (% of total)	Mean/trap (SEM)[2,3,4]	Nulliparous[3]	Parous[3]	Gravid[3]	No. containing blood (%)[3]
Landing/biting collection	32	1,072 (84.3)	33.5 (7.03) a	10.5 a	79.6 a	9.9 a	492 (45.9) a
Fay–Prince trap	32	108 (8.5)	3.4 (1.16) b	14.8 ab	81.5 a	3.7 b	10 (9.3) ab
Wilton trap	32	92 (7.2)	2.9 (0.89) b	23.9 b	71.7 a	4.3 ab	9 (9.8) ab
Sticky lure	32	0 (0.0)	0.0 (—) b	NA[5]	NA	NA	NA
Total	128	1,272 (100)	9.9 (2.15)	11.9	79.2	9.0	511 (40.2)

[1] Biting collections were made for 9 h (0800–1700 h) daily, with a 10-min rest period each hour. Other traps were placed at 0800 h each day and mosquitoes collected at 1700 h.

[2] Means in the same column followed by the same letter are not significantly different (analysis of variance with Tukey's mean separation procedure, $P > 0.05$).

[3] Values (raw data) in the same column followed by a different letter are significantly different (χ^2; $P < 0.05$).

[4] SEM, standard error of the mean.

[5] NA, not available.

Trap placement: Traps were placed in each house at 0800 h and removed at 1700 h. The ODFP and WT were baited with 1 kg of dry ice in a plastic container and the traps were placed 1 m above the ground in a corner of a room in each house. A single SL was placed on the wall of each house in approximately the same location that the ODFP and WT were placed. A single human volunteer sat in a chair in the same location as the other traps that were tested. Mosquitoes were collected by using a glass vial as they landed or attempted to bite exposed legs. Collections were made for 50 min each hour, with a 10-min rest period. Mosquitoes were collected at the end of each day, sorted, and identified to species. All specimens were checked for the presence or absence of blood and parity determined by using the Detinova method (Landry et al. 1988).

Data analysis: Trap collection data were transformed to $\log(x + 1)$ before analysis. Trap, day, replicate, and location effects were evaluated by using 3-way analysis of variance (ANOVA, SAS Institute 1995) for each of the 4-day sampling periods. Mean comparisons were made by using the Tukey's mean separation procedure ($\alpha = 0.05$). Chi-square analysis was used to determine whether the proportion of *Ae. aegypti* that were nulliparous, parous, or gravid in each trap was different from the proportion collected in the other traps.

RESULTS

A total of 1,272 adult *Ae. aegypti* was collected over the course of the study. No other mosquito species were collected. More than 84% (1,072) of *Ae. aegypti* were captured during L/B collections, with 8% (108), 7% (92), and 0% (0) collected with ODFP, WT, and SL, respectively (Table 1). Although no significant differences were found in mean numbers of adult *Ae. aegypti* collected per trap day by the ODFP, WT, and SL, all 3 traps collected significantly fewer *Ae. aegypti* than did L/B collections (Table 1). Landing/biting collections were approximately 10 times more effective at collecting *Ae. aegypti* than either the ODFP or WT, with a mean of 33.5, 3.4, and 2.9 mosquitoes, respectively, collected per trap or person per day.

The WT caught a significantly higher proportion of nulliparous *Ae. aegypti* than did L/B collections, whereas a significantly higher proportion of gravid adults were caught in L/B collections than in the ODFP. No other significant differences in age grade were found (Table 1). Almost 50% of the *Ae. aegypti* collected during L/B collections contained some blood, whereas only 10% of adults collected in the ODFP and WT contained blood (Table 1).

DISCUSSION

Examination of results from this study clearly demonstrates that L/B collection is significantly more effective at collecting adult *Ae. aegypti* in Thailand than the ODFP, WT, or SL. Landing/biting collections, ODFP, and WT were specific for *Ae. aegypti*; however, this was due to the fact that *Ae. aegypti* was the only mosquito species active indoors during the study period (0800–1700 h). Although the ODFP, the WT, and the SL were developed as tools for the collection of adult *Ae. aegypti*, each of these traps collected less than 10% of the number collected during L/B collection. Although some collections from houses yielded higher numbers of *Ae. aegypti* than did other houses, ANOVA clearly demonstrated that the type of trap was the most significant factor affecting numbers of mosquitoes collected and that date of collection and trap location did not significantly affect the outcome of the study.

In a previous study (R.E.C., unpublished data), we found that the Fay–Prince trap baited with dry ice captured a mean of 1.2 *Ae. aegypti* per 8-h trap day, whereas L/B collections yielded a mean of 0.4 *Ae. aegypti* per 20-min period. When adjusted for duration of collection (assuming a constant L/B intensity throughout the day), these values indicate that L/B collections (9.6 mosquitoes per 8-h trap

day) were 8 times as effective as the ODFP. Although the biting intensity in the current study was significantly higher (33.5/trap day versus 9.6/trap day) than in our previous study, the relative efficacy of L/B collection compared to the ODFP was similar in both studies. Canyon and Hii (1997) found that a bidirectional Fay–Prince trap baited with dry ice captured a mean of 1.8 *Ae. aegypti* over a 14-h period, whereas 10-min landing collections resulted in a mean of 1.7 (morning) or 3.6 (evening) *Ae. aegypti*. Examination of these data suggests that the Fay–Prince trap is significantly less efficient than L/B collection. Canyon and Hii (1997) suggested that L/B collection was still the preferred surveillance method in areas not currently experiencing arbovirus transmission.

The SL used in this study did not capture any *Ae. aegypti*. Although only a single SL was placed in each house, SL placed outside houses also failed to collect either *Ae. aegypti* or *Ae. albopictus* (J.W.J., unpublished data). Although Bangs et al. (2001) reported that dengue virus RNA could be detected in laboratory mosquitoes exposed to sticky lures, they did not report the field efficacy of the SL. Previous studies have reported that various trapping methods using a sticky material are useful for the collection of mosquitoes (Service 1993, Ryan and Kay 2000, Kay et al. 2000); however, to our knowledge no other published studies have evaluated the efficacy of the SL distributed by Austech International Pty., Ltd.

Although less effective than L/B collections, our study suggests that the ODFP and the WT may be useful tools for conducting surveillance of adult *Ae. aegypti*. Further studies are required to fully evaluate the efficacy of the SL.

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