

## SCIENTIFIC NOTE

### EVALUATION OF THREE TRAPS FOR SAMPLING *Aedes POLYNESIENSIS* AND OTHER MOSQUITO SPECIES IN AMERICAN SAMOA<sup>1</sup>

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**ABSTRACT.** The efficacy of the recently developed BG-Sentinel™ mosquito trap baited with BG-Lure (a combination of lactic acid, ammonia, and caproic acid) was evaluated in American Samoa against the omnidirectional Fay–Prince trap and the Centers for Disease Control and Prevention (CDC) light trap, both baited with carbon dioxide. The BG-Sentinel trap captured the greatest number of the important filariasis and dengue vector *Aedes (Stegomyia) polynesiensis* at all 3 collection locations; however, its catch rate was not significantly different from that of the Fay–Prince trap at 2 of the 3 trapping locations. The CDC light trap caught very few *Ae. polynesiensis*. The Fay–Prince trap was more efficient than the other 2 traps for collecting *Aedes (Aedimorphus) nocturnus*, *Aedes (Finlaya) spp.*, *Culex quinquefasciatus*, and *Culex annulirostris*. The efficacy and convenience of the BG-Sentinel suggest further research is warranted to evaluate its potential as a possible efficient and safe alternative to landing catches for sampling *Ae. polynesiensis* in research and control efforts against filariasis and dengue in the South Pacific.

**KEY WORDS** *Aedes polynesiensis*, BG-Sentinel, Fay–Prince, CDC light trap, South Pacific

*Aedes (Stegomyia) polynesiensis* Marks is the most important filariasis vector across much of the South Pacific between Fiji and French Polynesia (Rosen 1955, Iyengar 1965, Ramalingam 1968). It is also an important secondary vector of dengue (Rosen et al. 1954) and was implicated as a major vector in a large regional outbreak of Ross River virus (Gubler 1981, Miles 1984). The lack of an effective trap for sampling *Ae. polynesiensis* remains a major impediment to ongoing research and control efforts against filariasis and dengue in the region. The Centers for Disease Control and Prevention (CDC) light trap and related mosquito trap designs have shown limited ability to capture *Ae. polynesiensis* (Russell 2004), and landing catches are labor-intensive and could put collectors at risk during arbovirus outbreaks. Recently a new type of trap, the BG-Sentinel™ (BioGents GmbH, Regensburg, Germany), which uses a lactic acid,

ammonia, and caproic acid mix as a lure, was developed for sampling *Aedes (Stegomyia) aegypti* (L.) (Kröckel et al. 2006, Williams et al. 2006). The BG-Sentinel and an earlier design, the omnidirectional Fay–Prince trap (Jensen et al. 1994), baited with carbon dioxide, gave promising results in preliminary trials in American Samoa (Ball 2005). In the work described here we compared efficacy of these 2 traps to that of the CDC light trap. Our efforts focused on *Ae. polynesiensis*, but we recorded and herein report other species captured in the 3 types of trap.

Three collection sites were established on the grounds of the American Samoa Community College Agricultural Experiment Station on Tutuila Island, American Samoa. The area contains 3 buildings housing offices and research laboratories, an open-sided garage, small agricultural plots and fruit plantings, a small piggery, and parking areas. Potential mosquito hosts include the station's field crew during working hours, the pigs confined in the piggery, stray dogs and cats, rats, wild birds, and fruit bats. Mosquito breeding sites in the form of small ground pools, various discarded water-holding containers, tree holes, plant leaf axils, and coconut shells are present throughout the area. The study area is situated at the base of a steep hillside of mixed secondary forest and taro and banana plantations. The 3 collection locations for trap placement (hereafter referred to as "shelter," "garage," and "piggery") were spaced approximately 100 m apart (the approximate maximum flight range of *Ae. polynesiensis* [Jachowski 1954]), and approximately 10–20 m from the forest edge. Traps were placed under the eaves

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of buildings to protect them from rainfall and on the sides of the buildings closest to the forest edge. The "piggery" and "garage" sites were close to possible hosts: pigs and humans, respectively. The "shelter" site, a small roofed shelter without walls, was in a location not frequented by humans or other large mosquito hosts.

Three traps were tested. The omnidirectional Fay–Prince trap (John W. Hock Co., Gainesville, FL) was baited with carbon dioxide emitted from a tank via a tube opening immediately above the center of the top of the trap. The CDC light trap (Clarke Mosquito Control, Inc., Roselle, IL) was equipped with a light that remained illuminated throughout the trapping period and was also supplied with carbon dioxide from a tank via a built-in fitting immediately under the trap lid. Carbon dioxide flow rates for the omnidirectional Fay–Prince and CDC light traps were controlled using preset regulators and 0.178-mm-diam orifices and averaged 282 ml/min under ambient conditions. Both traps were powered by 6-V batteries. The BG-Sentinel trap was powered by a 12-V battery and contained the manufacturer's BG-Lure, a mixture of lactic acid, ammonia, and caproic acid inside a coiled dispenser tube. All the traps were suspended with openings approximately 1 m from the ground surface. A 3-cm band of Tanglefoot (The Tanglefoot Company, Grand Rapids, MI) was applied to the suspension ropes, carbon dioxide tubes, and battery cables to prevent ant entry to the traps.

Experiments were conducted over a 7-wk period during March–May 2006. The 3 traps—one of each type—were operated for 3 consecutive days each week. To reduce the likelihood of bias due to trapping location or date, the 3 traps were rotated daily among the 3 trapping sites, with placements each day determined as a 3 × 3 Latin square, with day and trapping site as the row and column variables. Thus, 1 3 × 3 Latin square was completed each week. The traps were rotated at 0730 h each day, and mosquitoes were removed daily at 0730 and 1830 h and identified using the keys and descriptions in Ramalingam (1976) and Huang (1977). A new Latin square was randomly generated for each of the 7 wk. Because of a significant site-by-treatment effect, data from each site were analyzed separately with week as a blocking factor. Daily counts of mosquito females were transformed as  $\log_{10}(x + 1)$  to correct for lack of normality and unequal variances in the raw data, and catches for the 3 traps at each site were compared using analysis of variance and mean separation by the Tukey multiple comparison procedure (SYSTAT 11, SYSTAT Software, Inc., Richmond, CA).

A total of 7,393 female mosquitoes of at least 10 species were captured in the traps (Table 1). *Aedes polynesiensis* was the most abundantly collected mosquito ( $n = 4,353$ ), followed by

*Aedes (Finlaya) spp.* ( $n = 2,461$ ), *Culex quinquefasciatus* Say ( $n = 274$ ), *Aedes (Aedimorphus) nocturnus* (Theobald) ( $n = 196$ ), *Culex annulirostris* Skuse ( $n = 93$ ), *Aedes (Stegomyia) upolensis* Marks ( $n = 12$ ), *Ae. aegypti* ( $n = 4$ ), *Toxorhynchites amboinensis* (Doleschall) ( $n = 1$ ), and *Coquillettia samoensis* Stone ( $n = 1$ ). American Samoa's 3 *Ae. (Finlaya) spp.* are difficult to distinguish (Ramalingam 1976) and were not separated for this study. Our trap catches of *Aedes (Finlaya) spp.* included some that could not be identified further, some that were clearly *Aedes (Finlaya) oceanicus* Belkin, and some that were either *Aedes (Finlaya) samoanus* (Gruenberg) or *Aedes (Finlaya) tutuilae* Ramalingam and Belkin.

The rankings of the traps from highest to lowest catch rate were consistent among the 3 locations for each mosquito species; however, the magnitudes of the differences between traps varied (Table 1). The BG-Sentinel caught the most *Ae. polynesiensis* ( $n = 2,758$ ). The omnidirectional Fay–Prince trap with carbon dioxide also captured large numbers of *Ae. polynesiensis* ( $n = 1,556$ ); the difference in catch rates between these 2 traps was large and statistically significant at 1 of the 3 sites, but not statistically significant at the other 2 sites (Table 1). The CDC light trap with light and carbon dioxide caught few *Ae. polynesiensis* ( $n = 39$ ) and does not appear to be useful for trapping this species in American Samoa. Few males were caught in any of the traps. Males comprised 3.9%, 2.5%, and 0.5% of the *Ae. polynesiensis* catch in the BG-Sentinel, CDC, and omnidirectional Fay–Prince traps, respectively. Catch rates for males of other species did not exceed 1 individual per trap per day in any of the traps.

In contrast to its performance with *Ae. polynesiensis*, the BG-Sentinel caught the fewest *Ae. nocturnus*, *Ae. (Finlaya) spp.*, *Cx. quinquefasciatus*, and *Cx. annulirostris* females. The omnidirectional Fay–Prince trap with carbon dioxide captured the greatest numbers of these species of the 3 traps examined (Table 1).

The BG-Sentinel trap without carbon dioxide was more efficient than the lighted CDC and the omnidirectional Fay–Prince traps with carbon dioxide for trapping the major disease vector *Ae. polynesiensis*. Although the omnidirectional Fay–Prince trap with carbon dioxide also captured relatively large numbers of *Ae. polynesiensis*, the need to transport carbon dioxide tanks into the field makes this combination less convenient than the BG-Sentinel. Also, the cost of the tanks and carbon dioxide would probably exceed that of the BG-Lure for most applications. The BG-Sentinel trap caught relatively few individuals of the species other than *Ae. polynesiensis*, but this selectivity would facilitate sorting and processing of the catch when *Ae. polynesiensis* is the trapping target. Use of carbon dioxide with the BG-

Table 1. Mean females/trap/day ( $\pm$ SE) at each location;  $n = 7$  days for each trap/location combination.<sup>1</sup>

Species <sup>2,3</sup>	Trap	Location		
		Shelter	Garage	Piggery
<i>Aedes polynesiensis</i>	BG	170.4 $\pm$ 22.7 a	76.4 $\pm$ 14.1 a	147.1 $\pm$ 39.5 a
	CDC	1.3 $\pm$ 0.3 c	1.0 $\pm$ 0.3 b	3.3 $\pm$ 1.5 b
	ODFP	35.9 $\pm$ 7.0 b	50.3 $\pm$ 6.3 a	136.1 $\pm$ 23.4 a
<i>Aedes nocturnes</i>	BG	0 b	0.1 $\pm$ 0.1 b	0 b
	CDC	2.0 $\pm$ 0.8 b	1.7 $\pm$ 1.1 ab	1.6 $\pm$ 0.6 b
	ODFP	7.9 $\pm$ 2.9 a	5.7 $\pm$ 1.6 a	9.0 $\pm$ 3.0 a
<i>Aedes (Finlaya) spp.</i> <sup>4</sup>	BG	4.1 $\pm$ 1.2 b	4.1 $\pm$ 1.5 b	0.7 $\pm$ 0.3 b
	CDC	62.7 $\pm$ 1.3 a	13.3 $\pm$ 4.9 b	20.9 $\pm$ 10.3 a
	ODFP	100.3 $\pm$ 23.5 a	102.9 $\pm$ 12.9 a	42.6 $\pm$ 12.4 a
<i>Culex quinquefasciatus</i>	BG	0.3 $\pm$ 0.2 b	0.6 $\pm$ 0.3 b	0.3 $\pm$ 0.3 b
	CDC	1.3 $\pm$ 0.3 b	0.7 $\pm$ 0.4 b	0.9 $\pm$ 0.3 b
	ODFP	16.4 $\pm$ 3.4 a	14.6 $\pm$ 3.6 a	4.1 $\pm$ 0.9 a
<i>Culex annulirostris</i>	BG	0 b	0.1 $\pm$ 0.1 a	0 b
	CDC	2.6 $\pm$ 1.5 ab	0.1 $\pm$ 0.1 a	2.3 $\pm$ 0.7 ab
	ODFP	3.0 $\pm$ 1.3 a	1.0 $\pm$ 0.5 a	4.1 $\pm$ 1.6 a

<sup>1</sup> BG, BG-Sentinel trap with manufacturer's lure; CDC, CDC trap with light and carbon dioxide; ODFP, omnidirectional Fay-Prince trap with carbon dioxide.

<sup>2</sup> For each species, means in the same column followed by the same letter are not significantly different (Tukey's multiple comparison test,  $P = 0.05$ , on  $\log_{10}(x + 1)$  transformed trap catches.)

<sup>3</sup> Other species captured: *Aedes (Stegomyia) upolensis* Marks: 3 in BG, 4 in CDC, 5 in ODFP; *Aedes aegypti*: 4 in BG; *Toxorhynchites amboinensis* (Doleschall): 1 in BG; *Coquillettidia samoensis* Stone: 1 in CDC.

<sup>4</sup> Included some individuals identifiable only as *Aedes (Finlaya) sp.*, some that could be distinguished as *Aedes (Finlaya) oceanicus* and others determined to be either *Aedes (Finlaya) samoanus* or *Aedes (Finlaya) tutuilae*.

Sentinel trap could help increase catches of some species, but this combination was not tested in this experiment.

Historically, human landing catches have been the primary tool for sampling adult *Ae. polynesiensis* because efficient traps were not available. The results presented here show that the BG-Sentinel trap can catch large numbers of *Ae. polynesiensis* and merits further evaluation as a potential tool for research and monitoring throughout the South Pacific where *Ae. polynesiensis* is an important vector of filariasis, dengue, and other diseases.

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