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FACTORS MODULATING CAPTURES OF GRAVID *AEDES AEGYPTI* FEMALES

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Abstract

To improve detection and assessment of *Aedes aegypti* (L.) abundance, we investigated if micro-habitat factors of the location of Autocidal Gravid Ovitraps (AGO traps) influenced captures of gravid females in two locations in southern Puerto Rico. One location had been under vector control for several years using mass AGO trapping (intervention site), where *Ae. aegypti* abundance was several times lower than in the other study site without mosquito control (nonintervention site). We observed ten environmental factors describing trap micro-habitat location, and monitored water volume, and minimum, maximum, and average temperature in AGO traps. Air temperature, relative humidity, and rainfall were recorded at each site. We conducted a hot-spot analysis of AGO traps to understand if trap captures were influenced by the local abundance of mosquitoes rather than or in addition to traps' micro-habitat factors. AGO traps were classified using a Two-Step Cluster analysis based on attributes of trap micro-habitats, water temperature, and water volume. Captures of female *Ae. aegypti* in each cluster per site were compared between resulting clusters to determine if trap micro-habitat factors defining the clusters were associated with trap captures. Trap captures in both study sites were mostly correlated with captures in nearby traps regardless of traps' micro-habitat factors, possibly reflecting the influence of the spatial aggregation of mosquitoes coming from nearby aquatic habitats or the concentration of dispersing adults. These results indicated that AGO traps can be located at places that can be easily reached during periodic inspections, such as in front of houses, without much regard to local micro-habitat conditions.

Keywords

Aedes aegypti ; AGO traps; mosquito surveillance; vector control

INTRODUCTION

The recent epidemic emergence of chikungunya and Zika viruses after decades of dengue virus circulation in tropical urban areas (Weaver and Forrester 2015, Gubler et al. 2017) underscores the need to improve our capacities to control *Aedes aegypti*. To achieve effective control, it is central that we efficiently detect and monitor this mosquito and

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determine what population levels are protective against rampant arbovirus outbreaks. Ovitraps were conceived and recommended as a more efficient means of detecting the presence of *Ae. aegypti* than container and house inspections during the eradication campaign in the Americas (Jakob 1969). The main reason for using presence / absence data was that when the objective of vector management is elimination of the mosquitoes, there is no interest in quantifying how many mosquitoes there are, but just determining if they are present or not.

One limitation of ovitraps when they are used to quantify the mosquito population is the skip oviposition behavior of *Ae. aegypti*, whereby eggs are distributed across several aquatic habitats (Reiter 2007). This behavior determines that the number of eggs per ovitrap depends on the local availability of alternate ovipositing sites (Focks 2003). Another limitation exists when more than one *Aedes* (*Stegomyia*) species co-occur, in which case egg hatching and larval rearing are usually required to separate species. Yet, ovitraps continue to be valuable tools for detecting the presence of container *Aedes* species in space and time, and they are particularly useful in areas where these species are expanding their geographical range, such as in California (Metzger et al. 2017).

Several efficient traps targeting gravid adult *Ae. aegypti* mosquitoes have been developed recently (Mackay et al. 2013, Eiras et al. 2014). In general, an efficient trap is one that accurately reflects the presence and relative abundance of a target organism when it is used in enough numbers with adequate spatial and temporal coverage. A relevant question is where to place gravid traps to maximize the chances of detecting and quantifying the relative abundance of an elusive organism such as *Ae. aegypti*? Determining an optimal trap location is important, but we also need to consider the need for having readily access to traps that are used for mosquito surveillance because they require frequent visits to multiple private-property locations in urban areas. The ovipositing behavior of *Ae. aegypti* in nature may not just be influenced by the quality of the aquatic habitats or their optimal location, but also by the availability of containers with water within the flight range and available time to lay the load of eggs within each gonotrophic cycle (Wong et al. 2011).

During the *Ae. aegypti* eradication campaign, the Centers for Disease Control and Prevention (CDC) issued the following recommendations for ovitrap placement: near other containers with water, in partial or total shade and avoiding direct sunlight, out of the way of children and pets, at ground level, on the rear or side of the house avoiding the front yard or near the street, close to typical mosquito resting sites, and avoiding locations with excess drain overhead (downspouts or broadleaf vegetation; Pratt and Jakob 1967). Some of the recommendations for ovitrap placement have been evaluated. For example, placing ovitraps in partial or total shade did not collect more eggs than those in direct sunlight (Chadee 1992, Rodriguez-Tovar et al. 2000) or ovitraps more exposed to the sun collected more eggs than those in the shade (Dibo et al. 2005, Harrington et al. 2008, Wong et al. 2011). For gravid traps, results showed similar capture rates of female *Ae. aegypti* in sticky traps exposed to the sun or in the shade (Williams et al. 2006) but greater captures were observed in shaded conditions in another study (Russell and Ritchie 2004). Placing sticky gravid traps at ground level collected more females of *Ae. aegypti* (Williams et al. 2006).

With the advent of larger traps for gravid females that may compete better with extant aquatic habitats than ovitraps, such as the CDC Autocidal Gravid Ovitrap (AGO trap; Mackay et al. 2013), it was considered that an evaluation of trap placement would be appropriate. The present investigation explored the variation in capture rates of *Ae. aegypti* females in AGO traps in relation to several trap location features in southern Puerto Rico. Determining optimal trap location for the detection of *Ae. aegypti* females in gravid sticky traps is important because like ovitraps, they are passive, relatively inexpensive traps that can be deployed and monitored in larger numbers than electromechanical traps. We conducted this investigation in two sites: one with vector control and low female *Ae. aegypti* abundance, and another one without vector control and high mosquito abundance. The main interest here was to understand if trap placement recommendations varied with local *Ae. aegypti* abundance.

MATERIALS AND METHODS

Study area

To understand if optimal trap location varied with the local abundance of *Ae. aegypti*, we conducted this investigation in an intervention site (IS) where female mosquito abundance was ten times smaller than in a nonintervention site (NIS) in southern Puerto Rico (Barrera et al. 2019). The IS was located in Guayama municipality (17˚ 58’ 13” N, 66˚ 10’ 48” W; 20 m elevation; 241 buildings) and the NIS was in neighboring Salinas municipality (17˚57’ 59” N, 66˚18’10” W; 1 m elevation; 269 buildings). Vector control in the IS was conducted using mass trapping of female *Ae. aegypti* (Barrera et al. 2014a, 2019). We used 27 and 28 fixed location AGO traps to monitor the capture rates of *Ae. aegypti* (adult mosquitoes/trap/week) in IS and NIS, respectively. There were no vector control interventions in NIS. All traps were serviced after two months to replace water, hay pack, and sticky board (Mackay et al. 2013).

The observation periods on the effect of trap location on mosquito captures in IS was from December 2016 to April 2017 and in NIS from April to July 2017. We were not interested in comparing mosquito abundance between sites because it had been done before (Barrera et al. 2019a). Our interest was to observe how the micro-habitat of trap location may affect trap captures in the study sites. Notwithstanding, because we monitored *Ae. aegypti* abundance for several weeks at each site, we needed to incorporate covariates that helped us understand temporal changes in the mosquito population. We have shown that *Ae. aegypti* populations in Puerto Rico, including the study sites, are significantly influenced by weather, mainly rainfall, relative humidity, and temperature (Barrera et al. 2011, 2019). For that reason, we recorded and calculated the following weather data from weather stations placed in both study sites: average daily air temperature and relative humidity during the three weeks preceding weekly mosquito collections (ºC), accumulated rainfall during the third and second weeks before mosquito collections, and weekly wind speed (HOBO Data Loggers, Onset Computer Corporation, Boume, MA; Barrera et al. 2011).

Factors influencing trap captures

The main aim of the study was to understand what micro-habitat factors of trap location significantly influenced AGO trap capture rate variations at sites with low and high *Ae. aegypti* abundance. AGO traps capture gravid females of *Ae. aegypti* looking for a water-holding container to lay their eggs (Mackay et al. 2013). The AGO trap captures mosquitoes on a sticky surface located inside a 3.8-liter black plastic capture chamber that is partially inserted into a 19-liter black plastic bucket with 10 liters of water and a 30-g hay grass packet (Barrera et al. 2014b). We hypothesized that trap attraction and capture may be explained by environmental factors associated with the location of the traps or micro-habitats. To understand if traps captured mosquitoes at random through time or if traps catches per trap were consistent over time, we examined if there was consistency in the rank order of AGO trap captures per week during the study at each site. Previous studies have shown significant concordance in the rank order of fixed-position trap captures of *Ae. aegypti* in urban San Juan, Puerto Rico (Barrera et al. 2011).

We considered the following fixed variables of traps' surroundings (Table 1). Trap location (front of the building vs. alongside or back of building) is of interest because it is much easier to obtain permission to place surveillance mosquito traps at the front of the buildings and to reach out to the traps during weekly visits than deeper into properties. Trap exposure to rain may influence trap water volume, and trap exposure to direct sun may affect water temperature inside the traps and evaporation rate. We noted if the traps were under a vegetation canopy, as shade may attract more mosquitoes, and traps could collect nutrients from through-fall rain that may enrich the water (Barrera et al. 2006). We noted if traps were on grassy vegetation, built, or bare ground. We also registered if the trap background was light or dark; possibly influencing the visual contrast with the dark color of the trap (Ball and Ritchie 2010). Another fixed variable was the distance from a trap to the nearest window or door (Salazar et al. 2018). Other recorded variables were presence or absence of pets (Mahadev et al. 2004) and whether the house was inhabited or not (Little et al. 2017; Table 1).

We also registered daily minimum, maximum, and average temperature of the water in the AGO traps and trap's volume (Onset HOBO Pendant® Temp / light, 8K, model UA-002-08, Onset Computer Corporation, Boume, MA). We also recorded if there were adult mosquitoes inside the infusion chamber at the time of trap inspection (Table 1). Protruded eggs from captured female *Ae. aegypti* can be washed through the screen into the infusion chamber by heavy rains, hatch, and develop into adults, and although they remain trapped in the infusion chamber (Acevedo et al. 2016), they may influence ovipositing females.

We also studied the spatial patterns of *Ae. aegypti* trap captures within the study sites. It is likely that regardless of the importance of local micro-habitat conditions on trap attraction, trap counts may simply reflect variations in spatial mosquito abundance brought about heterogeneous mosquito productivity in water-filled containers around traps. To understand the influence of mosquito abundance around each trap, we calculated the Getis-Ord $G_i(d)$ statistic for each of the 16 weeks in the two study sites.

Data analyses

We calculated Kendall’s W coefficient of concordance to determine if the rank order of mosquito catches per trap per week for all deployed traps at each site was consistent throughout the study period. The index varies between 0 (random trap-capture order) and 1 (consistency in mosquito trap captures). A significant coefficient would indicate that traps capturing high numbers of female *Ae. aegypti* tended to capture high numbers of this mosquito through the period of observation and vice versa.

AGO traps were classified using a Two-Step Cluster analysis based on attributes of trap micro-habitat, trap water temperature, and water volume (Table 1). Because mean water temperature had the highest correlation with minimum and maximum water temperature in both study sites, the former was used for the analysis. Continuous variables (trap water volume, mean temperature) were standardized. Cluster similarity was calculated using log likelihood. The Two-Step Cluster analysis selects the optimum number of clusters using Schwarz’s Bayesian Information Criterion (BIC), ratio of BIC changes, and ratio of distance measures against an increasing number of clusters. The purpose of this analysis was to determine if AGO traps could be grouped based on trap micro-habitat variables and then examine if resulting clusters had any significant relationship with the numbers of female *Ae. aegypti* captured in traps.

Mean female *Ae. aegypti* captures between clusters at each site were compared using a Generalized Linear Model (GLM) under the null hypothesis of no significant ($\alpha = 0.05$) differences between clusters. We used the G_i(d) Z-values to account for spatial aggregation of female *Ae. aegypti* and weather parameters as covariates to account for temporal changes in mosquito counts per trap per week (Table 1). The probability distribution of female mosquito abundance was a Negative Binomial with log link. The covariance of repeated measures (16 weeks) was an autoregressive function of order one.

The Gi(d) index uses the numbers of *Ae. aegypti* in nearby traps, not including the number of mosquitoes at the trap in reference, and produces a Z-value indicating whether the trap was located at a cluster of mosquitoes (hot spot; Ord and Getis 1995). High Z-values will be seen in traps that are surrounded by traps with high mosquito counts. Calculation of Gi(d) Z-values were performed using GeoDa software 1.12.1 (Anselin et al. 2006) and ArcGIS Pro 2.3.0. (ESRI, Redlands, CA). The search distance for neighboring traps was 110.6 meters.

RESULTS

Kendall’s concordance coefficient W was significant, showing that traps were consistent in their rank order of captures per week for the 16 weeks of observations in NIS ($W= 0.42$; $\chi 2= 163$; df= 15; $P< 0.001$). A smaller but significant coefficient was obtained for traps in IS ($W= 0.21$; $\chi 2= 79$; df= 15, $P < 0.01$). These results indicated that trap captures in time were not random and that there was some structure that determines that some traps consistently captured more (or less) *Ae. aegypti* throughout the study period.

The average numbers of female and male *Ae. aegypti* per trap per week in IS (N= 429) were 0.98 ± 0.06 and 0.13 ± 0.03, respectively. For NIS, the average numbers of female and male

Ae. aegypti per trap per week (N= 445) were 17.59 ± 0.77 and 1.71 ± 0.1677, respectively. Differences in trap captures between these two sites have been reported elsewhere (Barrera et al. 2014b, 2019).

Weather during the study in IS was cooler and drier (December 2016 to April 2017) than during the study in NIS (April – July 2017), as indicated by the lower average air and trap water temperatures and rainfall in IS (Table 1). Traps in NIS were more frequently placed in front of occupied properties, exposed to rain, in partially shaded locations, not under vegetation, and on built ground (Table 1). These conditions reflected the preference and practice for selecting sites followed by our team when we initiated studies in these locations several years ago (Barrera et al. 2014a, b). A cursory look at average trap captures with contrasting site conditions in NIS would suggest that more female *Ae. aegypti* would have been retained in traps exposed to rain, partially shaded, under vegetation, on built ground, and in inhabited houses with pets (Table 2). Given the low capture values of traps in IS, it is more difficult to appreciate differences in mosquito densities (Table 2). Simple statistical comparisons (e.g., t-test) of trap capture between contrasting individual conditions (e.g., traps exposed or not exposed to rain) were not made because there were many variables associated with trap location, and comparisons of individual variables would be meaningless if we ignored the influence of the other variables.

The Two-Step Cluster analysis produced two clusters of traps in NIS: Cluster 1 with 15 traps and Cluster 2 with 12 traps. Traps in Cluster 1 had lower average water temperature (29.5 ± 0.2°C), all traps were in partial or total shade (100%), in backyards (60%) of inhabited houses (100%), and several had a vegetation canopy (40%). Traps in Cluster 2 had higher water temperature (30.7 ± 0.2°C), were more frequently exposed to the sun (66.6%), and most were located at the front of properties (92%; Table 3). Average female *Ae. aegypti*/trap/week was 18.7 ± 1.1 in Cluster 1 and 17.1 ± 1.0 in Cluster 2. The Generalized Linear Model of average female *Ae. aegypti* per trap per week per cluster, with $G_i(d)$ and weather variables as covariates was significant ($F_{6,\,422} = 6.25$; $P < 0.001$). Average numbers of female *Ae. aegypti*/trap/week between Clusters 1 and 2 were not significantly different ($F_{1,\,423} = 0.03$; $P > 0.05$). There were significant effects of $G_i(d)$ ($F_{1,\,422} = 9.7$; $P < 0.01$) and wind speed ($F_{1,\,422} = 21.44$; $P < 0.001$). The fixed coefficient for $G_i(d)$ (0.17) was positive showing increased captures in traps surrounded by traps with high captures and it was negative for wind speed (−0.62), suggesting fewer traps captures at higher wind speeds.

The Two-Step Cluster analysis also produced two clusters of traps in IS: Cluster 1 with 18 traps and Cluster 2 with nine traps. Traps in Cluster 1 had lower water temperature (26.6 ± 0.2°C), larger water volume (7.4 ± 0.1 l), and were located in partial or total shade (83.3%). Conversely, traps in Cluster 2 had higher water temperature (28.2 ± 0.3°C), smaller water volume (6.4 ± 0.2 l), and most traps were exposed to the sun (78%; Table 4). Average female *Ae. aegypti*/trap/week was 1.09 ± 0.08 in Cluster 1 and 0.75 ± 0.09 in Cluster 2. The Generalized Linear Model of average female *Ae. aegypti* per trap per week per cluster, with $G_i(d)$ and weather variables as covariates was significant ($F_{6,\,422} = 12.45$; $P <$ 0.001). Average numbers of female *Ae. aegypti*/trap/week between Clusters 1 and 2 were not significantly different ($F_{1,\,422} = 3.74$; $P > 0.05$). There were significant effects of $G_i(d)$ ($F_{1,\,422} = 12.73$; $P < 0.001$), air temperature ($F_{1,\,422} = 8.41$; $P < 0.01$), and relative humidity

($F_{1,\,422} = 8.87$; $P < 0.01$). Coefficients for $G_i(d)$ (0.22), air temperature (0.49), and relative humidity were positive (0.13).

DISCUSSION

This investigation explored the variation of several location factors of gravid traps on the capture rate of adult female *Ae. aegypti* in two neighborhoods, one subjected to mosquito control and small mosquito abundance and the other one without any control intervention and high mosquito abundance. This knowledge is important to optimize the detection and estimation of the relative abundance of this arbovirus vector and to understand its oviposition behavior. The analyses of the results did not identify significant micro-habitat factors influencing capture rates of gravid *Ae. aegypti*. Rather, trap captures were significantly associated with the local abundance of this mosquito, as indicated by the capture rates of neighboring traps (hot spot analysis) and by seasonal changes driven by weather. In other words, regardless of trap micro-habitat, gravid *Ae. aegypti* captures seemed to reflect the local abundance around traps. The concordance analyses, showing that traps with high captures tended to keep high captures throughout the study and vice versa, seems to indicate that trap location is important but not necessarily only related to micro-habitat factors. Candidate explanations are the aggregation of productive, persistent aquatic habitats (e.g., septic tanks; Barrera et al. 2008) and the concentration of dispersing adults in certain areas of the neighborhoods (Maciel de Freitas 2008, 2010). A similar pattern was observed before in other neighborhoods in Puerto Rico using BG traps (Barrera 2011). Thus, trap micro-habitat would be of secondary importance to other aspects of reliable sampling, such as using enough traps with a good coverage of the study area (Mackay et al. 2013).

Because several studies have reported higher frequency of containers with *Ae. aegypti* immatures in shaded areas associated with vegetation (Barrera et al. 1981, 2006, Tun-Lin et al. 1995, 2000, Vezzani et al. 2005, 2009), we were expecting to find more gravid females in traps under those conditions, but the differences were not significant. However, traps located in shaded conditions do not seem to consistently attract more females or greater oviposition by *Ae. aegypti* (Chadee 1992, Rodriguez-Tovar et al. 2000, Dibo et al. 2005, Harrington et al. 2008, Wong et al. 2011). One would expect that gravid females of *Ae. aegypti* would choose containers with conditions that maximize growth and survival of their offspring. Yet, a direct relationship between micro-habitat conditions of the containers where oviposition takes place and the productivity of those containers does not always hold (Wong et al. 2012). A possible explanation for this mismatch is that females of *Ae. aegypti* do not lay all their eggs in a single container (Reiter 2007), so that eggs are laid in containers with water as they are discovered within the time available to spread them. Additionally, one reason why exposure of containers to the sun may be irrelevant for choosing oviposition sites is that most *Ae. aegypti* oviposition happens before sunset (Chadee and Corbet 1987, Harrington et al. 2008), as originally discussed by Chadee (1992).

Lack of significant differences in capture rates of *Ae. aegypti* between traps located at the front of houses near streets, compared with sites deeper into the properties, means that trap operators can more easily check the traps. Thus, the results of this investigation indicate that gravid trap deployment for reliable detection and quantification of the relative abundance of gravid *Ae. aegypti* females is not bound to the selection of specific micro-habitat conditions.

Conducting this study in areas with low and high abundance of *Ae. aegypti* seems to add consistency to our conclusions despite the substantial differences in *Ae. aegypti* abundance between sites. It is important to examine the performance of traps across a range of mosquito densities, particularly at the lower end, where inefficient traps may not have enough sensitivity to detect *Ae. aegypti*. Additionally, if adult traps are used to evaluate the impact of vector control, they should provide accurate estimates as the mosquito population goes down. For AGO traps, their capture rates were compared with those in BG Sentinel traps in the field for over a year at high and low *Ae. aegypti* abundance, providing a highly significant log-linear relationship of capture rates between the two traps at both mosquito densities (Barrera et al. 2014b).

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Table 1.

Relative abundance of *Ae. aegypti* in AGO traps and number of traps with given micro-habitat features, and weather variables observed in IS, Guayama municipality (mass-trapping intervention site) from December 2016 to April 2017 and in NIS, Salinas municipality (nonintervention site), Puerto Rico from April to July 2017.

Variable name	**Units/Code**	**IN surveillance traps – Average ± Standard Error (sample size) or # of traps**	**NIS surveillance traps - Average ± Standard Error (sample size) or # of traps**
Number of *Aedes aegypti* females	Individuals/trap/week	0.98 ± 0.06 (429)	17.59 ± 0.77 (445)
Trap location (building)	Front (0), Elsewhere (alongside, back) (1)	16, 11	17, 10
Trap exposure to rain	No (0), Yes (1)	3, 24	4, 24
Trap exposure to sun	Total (0), Partial/shade (1)	10, 17	8, 20
Trap under vegetation	No (0), Yes (1)	20, 7	21, 7
Ground cover under trap	Grass (0), Built (1)	4, 23	5, 23
Trap background	Dark (0), Light (1)	20, 7	10, 18
Presence of adult mosquitoes alive in infusion chamber*	No (0), Yes (1)	414, 15	328, 91
Distance to nearest window or door	Meters	2.85 ± 0.44 (27)	4.48 ± 0.64 (27)
Trap water volume	Liters	7.05 ± 0.06 (429)	7.21 ± 0.06 (445)
Trap water minimum daily temperature	°C	22.67 ± 0.66 (401)	25.02 ± 0.10 (445)
Trap water maximum daily temperature	°C	33.29 ± 0.18 (401)	36.69 ± 0.18 (445)
Trap water mean daily temperature	°C	27.10 ± 0.07 (401)	29.93 ± 0.08 (445)
House occupancy	Uninhabited (0), inhabited (1)	8, 19	4, 23
Pet presence	No (0), Yes (1)	18, 9	11, 17
Mean daily temperature **	°C	25.72 ± 0.14 (16)	27.79 ± 0.32 (16)
Mean daily Relative humidity **	%	74.70 ± 0.75 (16)	76.08 ± 0.67 (16)
Weekly rainfall **	mm	11.71 ± 3.99 (16)	18.43 ± 5.01 (16)
Mean daily wind speed **	m/s	1.0 ± 0.09 (16)	1.77 ± 0.07 (16)

*Following heavy rains, protruded eggs from captured female *Ae. aegypti* can be washed through the screen into the infusion chamber, hatch, and develop into adults that remain trapped within the infusion chamber

**Measured at meteorological stations located at study sites

Table 2.

Mean and standard error (sample size) of *Ae. aegypti* in AGO traps by traps' micro-habitat feature in the intervention site (IS) from December 2016 to April 2017 and in the non-intervention site, (NIS) Puerto Rico from April to July 2017.

Variable name	Descriptive	IS	NIS
Trap location at property	Front	1.02 ± 0.08 (257)	15.96 ± 0.79 (271)
	Elsewhere (alongside, back)	0.92 ± 0.10 (172)	21.48 ± 1.62 (158)
Trap exposure to rain	No	1.06 ± 0.22 (48)	11.65 ± 0.99 (62)
	Yes	0.97 ± 0.07 (381)	18.55 ± .87 (383)
Trap exposure to sun	Yes	0.76 ± 0.09 (157)	14.38 ± 1.27 (128)
	Partial/shade	1.11 ± 0.09 (272)	18.88 ± 0.94 (317)
Trap under vegetation	No	0.97 ± 0.08 (321)	16.68 ± 0.81 (333)
	Yes	1.01 ± 0.11 (108)	20.30 ± 1.83 (112)
Ground cover under trap	Grass	0.99 ± 0.16 (67)	10.20 ± 0.74 (80)
	Built	0.98 ± 0.07 (362)	19.21 ± 0.90 (365)
Trap's location background	Dark	1.02 ± 0.13 (112)	18.45 ± 1.12 (157)
	Light	0.97 ± 0.07 (317)	17.12 ± 1.02 (288)
Presence of adult mosquitoes alive in infusion chamber*	No	0.98 ± 0.07 (414)	15.99 ± 0.83 (328)
	Yes	1.00 ± 0.28 (15)	18.58 ± 1.35 (83)
House occupancy	Uninhabited	1.17 ± 0.13 (128)	15.48 ± 1.65 (67)
	Inhabited	0.90 ± 0.07 (301)	18.46 ± 0.88 (362)
Pet presence	No	1.09 ± 0.08 (287)	15.10 ± 1.00 (174)
	Yes	0.77 ± 0.09 (142)	19.18 ± 1.07 (271)

*Following heavy rains, protruded eggs from captured female *Ae. aegypti* may be washed through the screen into the infusion chamber, then hatch and develop into adults that remain trapped within the infusion chamber.

Table 3.

Trap location features of AGO traps and percentage of traps in classified clusters (1, 2) at the nonintervention (NIS) site, Salinas municipality, Puerto Rico from April to July 2017.

Variable name	Units or Descriptive	Cluster 1 (n=15)	Cluster 2 (n=12)
Trap water temperature	°C	29.5 ± 0.2	30.7 ± 0.2
Trap exposure to sun	Total / Shade	0 / 100	66.6 / 33.3
Trap location at property	Front / Elsewhere (alongside, backyard)	40.0 / 60.0	91.6 / 8.3
Trap under vegetation	No / Yes	60.0 / 40.0	100 / 0
House occupancy	Uninhabited / Inhabited	0 / 100	33.3 / 66.6
Trap water volume	Liters	7.4 ± 0.1	7.0 ± 0.2
Pet presence	No / Yes	26.6 / 73.3	58.3 / 41.6
Trap's location background	Dark / Light	46.6 / 53.3	10.0 / 90.0
Presence of adult mosquitoes alive in infusion chamber*	No / Yes	76.0 / 24.0	93.0 / 17.0
Ground cover under trap	Grass / Built	20.0 / 80.0	8.3 / 91.6
Trap exposure to rain	No / Yes	20.0 / 80.0	5.0 / 95.0

*Following heavy rains, protruded eggs from captured female *Ae. aegypti* may be washed through the screen into the infusion chamber, then hatch and develop into adults that remain trapped within the infusion chamber.

Table 4.

Trap location features of AGO traps and percentage of traps in classified clusters (1, 2) at the intervention (IS) site, Guayama municipality, Puerto Rico from December 2016 to April 2017.

Variable name	Units or Descriptive	Cluster 1 (n=18)	Cluster 2 (n=9)
Trap water temperature	°C	26.6 ± 0.2	28.2 ± 0.3
Trap exposure to sun	Total / Shade	16.6 / 83.3	77.7 / 22.2
Trap location at property	Front / Elsewhere (alongside, backyard)	55.5 / 44.5	66.6 / 33.3
Trap under vegetation	No / Yes	61.1 / 38.8	100 / 0
House occupancy	Uninhabited / Inhabited	38.8 / 61.1	33.3 / 66.6
Trap water volume	Liters	7.3 ± 0.1	6.4 ± 0.2
Pet presence	No / Yes	77.7 / 22.2	44.4 / 55.5
Trap's location background	Dark / Light	38.8 / 61.1	0 / 100
Presence of adult mosquitoes alive in infusion chamber[*]	No / Yes	97.0 / 3.0	96.0 / 4.0
Ground cover under trap	Grass / Built	5.5 / 94.4	33.3 / 66.6
Trap exposure to rain	No / Yes	20 / 80	11.1 / 88.8

[*] Following heavy rains, protruded eggs from captured female *Ae. aegypti* may be washed through the screen into the infusion chamber, then hatch and develop into adults that remain trapped within the infusion chamber.