EFFECTIVENESS OF THREE OVITRAPS IN THE MANAGEMENT OF DENGUE VECTOR *AEDES* MOSQUITOES IN BANGLADESH

Nusrat Jahan Chaiti, Kabirul Bashar*, Robiul Islam, Farhan Chowdhury Apon, Neshat Jahan, Md. Naiem, Afsana Al Latif and Tabassum Mostafa Mim

Insect Rearing and Experimental Station (IRES), Department of Zoology, Jahangirnagar University, Savar, Dhaka 1342, Bangladesh

ABSTRACT: Dengue poses a serious threat to many countries, including Bangladesh. *Aedes aegypti* and *Aedes albopictus* are the major vectors of dengue disease. This study was carried out to evaluate three types of passive Ovitraps (INZECTO Mosquito trap, Gravitrap and BG-GAT) to determine their effectiveness in reducing dengue burden in Bangladesh and to find out the preferred egg laying habitat of *Aedes albopictus*. Four INZECTO Mosquito traps, one Gravitrap and one BG-GAT were deployed, where Gravitrap and BG-GAT target adult mosquitoes and INZECTO Mosquito trap targets larvae. Four Inzecto mosquito traps were placed in different vegetative environments to identify egg-laying habitats of *Aedes albopictus*. Larvae were collected from the INZECTO trap weekly, and adults were gathered from the Gravitrap and BG-GAT twice a week. For testing IGRs like Pyriproxyfen, larvae were collected after twelve days. The mean larval densities from the INZECTO mosquito traps were 12.125, 26.375, 19.375 and 59.5. Result showed that Aedes albopictus preferred laying eggs in dense vegetation with large trees and tall grasses, with the highest larvae count of 59.5. A significant positive relationship (p<.001) existed between dense vegetation and larval numbers. The result indicated that Pyriproxyfen prevented larvae from maturing into adults. The average adult capture density was 3±0.31 for BG-GAT and 5±0.41 for Gravitrap, with Gravitrap being 1.7 times more efficient in terms of adult capturing. Mosquitoes favored laying eggs in ground traps over those in trees. Gravitrap and Inzecto mosquito trap are more effective than BG-GAT. By leveraging larval Inzecto trap and adult Gravitrap for both surveillance and regular monitoring of the vector population can help in predicting dengue outbreaks in Bangladesh.

Key words: Dengue, *Aedes aegypti, Aedes albopictus*, INZECTO mosquito trap, Gravitrap, BG-GAT, Passive Ovitraps, Mass-trapping

INTRODUCTION

Dengue is a serious public health concern worldwide. Dengue viruses are nurtured and transmitted predominantly by *Aedes aegypti* (Bashar *et al.,* 2005),

and *Aedes albopictus* acts as a secondary vector of Dengue Virus. Dengue incidence has been high in recent years and is present in more than 140 countries (da Costa *et al.,* 2017). The majority of its range is in the tropics and subtropics.

Dengue poses a serious threat to many countries, including Bangladesh. The epidemiology of dengue in Bangladesh is experiencing a subtle shift (Bashar *et al.,* 2020 and 2013). In the absence of vaccines or therapeutic options, the prevention of dengue fever largely depends on the surveillance and control of mosquito vectors (Tan *et al.,* 2011; Voge *et al.,* 2013). Control of vector mosquitoes of dengue in Bangladesh typically involves residual spraying of homes and surrounding areas with adulticides, treatment of peri-domestic water containers using larvicides or larval habitat source reduction (Flores-Suarez *et al.,* 2016). However, these strategies have been insufficient for the sustained control of *Aedes* mosquitoes and the reduction of human *Aedes*-borne diseases. For controlling the dengue vectors various ovitrap devices have been evaluated as tools for suppressing *Aedes aegypti* populations (Chan, 1972; Regis *et al.,* 2008; Perich *et al.,* 2003). Lethal ovitraps, which contain an oviposition substrate treated with a residual insecticide (Zeichner and Perich, 1999) and sticky ovitraps eliminate gravid female mosquitoes as they attempt to oviposit inside the trap (both referred to collectively hereafter as "gravid ovitraps"; GOs), thereby reducing the daily survival rate of the fraction of the adult vector population most likely to be infective and potentially lowering vectorial capacity. Furthermore, studies conducted in other countries such as Colombia, Maxico, Singapore and the US have demonstrated variable effectiveness of these traps for *Ae. aegypti* surveillance and control (Montenegro *et al.,* 2020; Martin *et al.,* 2019; Obregon *et al.,* 2019).

There are few studies in Bangladesh that focus on using ovitraps to control dengue vectors and monitor the dengue vector population. The present study was carried out to evaluate three different types of passive ovitraps (INZECTO Mosquito trap, Gravitrap and BG-GAT) and to find out the effective ovitraps that can play a vital role in reducing dengue burden of Bangladesh. Additionally, to find out the preferred breeding sites of *Aedes albopictus.*

MATERIAL AND METHODS

Study area and period: This study was conducted at the Insect Rearing & Experimental Station (IRES), a dedicated facility of the Department of Zoology, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh, from August to September 2023, during the rainy season. The geographical location of this site is 23.874903 N and 90.266568 E recorded using GPS essential apps in the device. The study location is residing in a region with tropical monsoon climate, distinguished by notable seasonal changes (dry winter period, a pre-monsoon hot and humid period, a monsoon season with heavy rainfall, and a post-monsoon period).

Trap positioning: Three different types of passive ovitraps were used in the study: Gravitrap (Biogents Gravid *Aedes* Trap) BG-GAT and Inzecto mosquito trap. Gravitrap and BG-GAT are passive adult sticky ovitraps that contained no insecticides, while Inzecto mosquito traps are passive larval ovitraps that contained pyriproxyfen as IGR and permethrin as adulticide. The study utilized four Inzecto mosquito traps, these traps were strategically positioned in diverse environments (Large trees, large and dense grasses, small grasses and large trees with dense large grasses) to identify the preferred egg laying habitat of *Aedes albopictus*. Additionally, one BG-GAT and one Gravitrap were used. Both traps were placed on the ground in similar vegetation and hay was used as attractants.

Inzecto mosquito trap	Gravitrap	BG-GAT

Collection and Identification of mosquitoes: Larvae were collected from four Inzecto mosquito traps weekly from August to September. Larvae from Inzecto mosquito traps were collected using plastic droppers. For the efficacy test of IGRs, Pyriproxyfen, the larvae on the Inzecto mosquito trap were observed after seven days and the opening was covered with net to prevent the escape of the adult. The developmental stages were collected after 12 days. The adult mosquitoes were collected from BG-GAT and Gravitrap twice weekly, with collections occurring every two days from August to September. Both are sticky passive adult ovitrap thus female mosquitoes were removed using fine forceps that had been dipped in mineral (paraffin) oil to prevent mosquitoes from adhering to the forceps. After collecting larvae and adult *Aedes spp.* the trap water was refreshed weekly from all traps. Following collection larvae and adult mosquitoes were carried to the laboratory at Jahangirnagar University to be identified morphologically under stereoscopic microscopes within 12 hours using taxonomic keys (Rueda, 2004; Le Goff *et al.,* 2012).

Data analysis: The average number of adult *Aedes spp.* captured by Gravitrap and BG-GAT traps, as well as the standard error (mean ± SE), were assessed. Additionally, the percentage of larval mortality after exposure to

Pyriproxyfen from the INZECTO trap was calculated. The comparative efficacy of adult captures between the Gravitrap and BG-GAT traps was visually represented using graphs. The percentage of larval mortality following exposure to Pyriproxyfen was calculated. All analyses were conducted using Microsoft Excel 2019. A one-way ANOVA was conducted to examine the effects of vegetation on the number of larvae found in the four INZECTO mosquito traps. Tukey's HSD test was performed for post-hoc comparisons and to determine significance. All analyses were conducted using SPSS Version 30.0.

RESULTS AND DISCUSSION

Gravitrap and BG-GAT showed variation in terms of capturing the average numbers of adult *Aedes spp.* Over the two-months data collection period, the Gravitrap captured an average of 5±0.41 adult *Aedes spp.* The number of mosquitoes captured across the 15 data collection days for the Gravitrap ranged from 3 to 8. During the two-months study period, the BG-GAT captured an average of 3±0.31 adult *Aedes spp.*, indicating a certain level of variability around the average. The number of mosquitoes collected by the BG-GAT across the 16 data collection days ranged from a minimum of 0 to a maximum of 5 (Table 1).

Table 1. The average number of adult *Aedes spp.* mosquitoes collected from the Gravitrap and BG-GAT over a two-months study period

Trap type	Data collection day	Mosquito captured by BG-GAT (M±SE)	Mosquito captured by Gravitrap (M±SE)
Adult sticky ovitrap	1 - 15	3±0.31	5±0.41

The comparison of adult capture efficiency between Gravitrap and BG-GAT was determined by observing the number of adults captured from August to September. Over the two-months study period, Gravitrap captured a total of 80 adult *Aedes spp.*, while BG-GAT captured 47 adult *Aedes spp.* This showed that Gravitrap had a higher adult mosquito capture efficiency, capturing almost 1.7 times more than BG-GAT (Figure 1). The result indicated that there is a clear association between the vegetation and the average larval density of *Aedes albopictus*. The average larval density per INZECTO trap varied considerably across different vegetation types over the two months. "Large trees and dense large grasses" exhibited the highest mean larval density, reaching approximately 60. Following this, "Large and dense grasses" showed a moderately high larval density of about 27. "Small grasses" had a lower mean larval density, around 20,
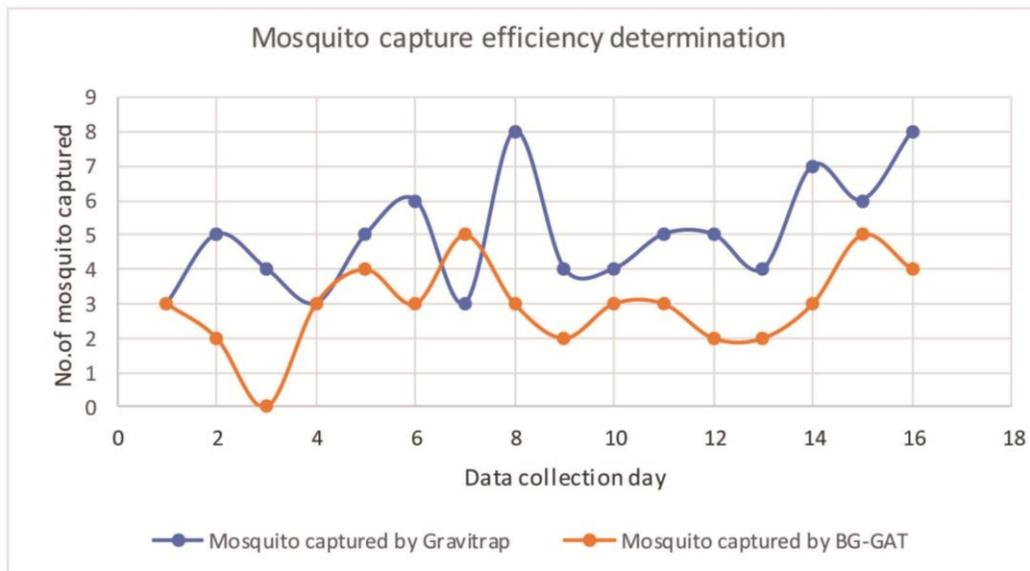
Fig. 1 Comparison of Adult Mosquito capture efficiency between BG-GAT and Gravitrap

Table 2. The result of One-way ANOVA of larval density of *Aedes albopictus* per INZECTO trap in relation to different vegetation.

Different Vegetation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10512.594	3	3504.198	1107.109	.000
Within Groups	88.625	28	3.165		
Total	10601.219	31			

while "Large trees" recorded the lowest average larval density, approximately 12.5 (Fig. 2). The result of a one-way analysis of variance (ANOVA) revealed a statistically significant difference between the groups, as indicated by the F $(3,28)$ =1107.109, p<.001. Specifically, the sum of squares between groups was 10512.594 with 3 degrees of freedom, while the within groups contributed a sum of squares of 88.625 across 28 degrees of freedom. The total sum of squares was 10601.219 across 31 degrees of freedom, indicating that the mean larval density differs significantly across the different vegetation groups (Table 2).

The result of a post-hoc Tukey's Honestly Significant Difference (HSD) test indicated that all pairwise comparisons between the vegetation groups showed statistically significant differences in mean larval density (p<.001 for all comparisons). Specifically, larval density was significantly lower in Large trees compared to Large and dense grasses (mean difference = -14.250), Small grasses (mean difference = -7.250), and Large trees and dense large grasses (mean

difference = -47.375). Furthermore, Large and dense grasses showed significantly higher larval density than Small grasses (mean difference = 7.000) but significantly lower density compared to Large trees and dense large grasses (mean difference = -33.125). Lastly, Small grasses had significantly lower larval density than Large trees and dense large grasses (mean difference = -40.125) (Table 3).
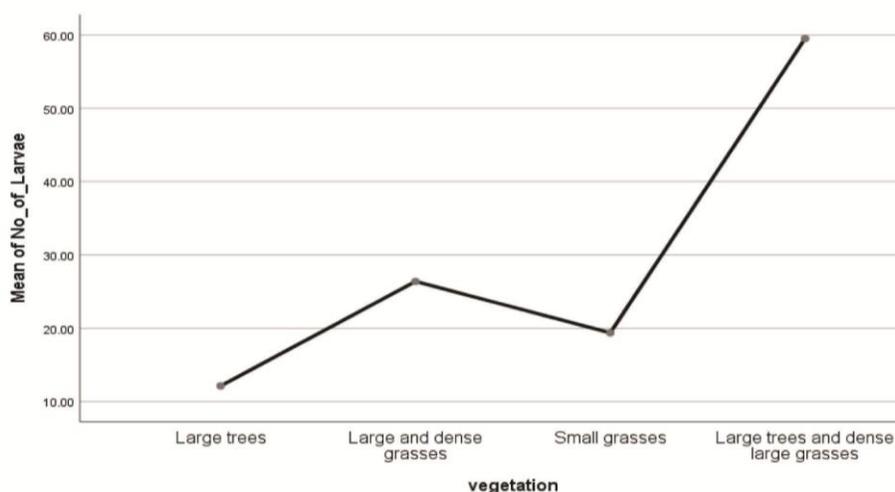

Fig. 2 The average larval density of *Aedes albopictus* per INZECTO trap in relation to different vegetation per week over a two-months study period.

The effects of IGRs Pyriproxyfen on developmental stages of *Aedes spp.* were examined and the result clearly showed that after exposure of *Aedes spp.* larvae to 0.31 ppm of pyriproxyfen resulted in 7% larval mortality. Among the surviving larvae, only 13 pupae emerged, and subsequently, no adults emerged (Table 4). In the present study, we have evaluated the efficacy of adult capture of *Aedes spp.* of both Gravitrap and BG-GAT. The result clearly showed that Gravitrap is more efficient in terms of adult mosquito capture and mass-trapping of adult *Aedes spp.* at household level can hold a promise to reduce dengue vectors in Bangladesh and can be used as surveillance and vector control tool which coincides with the findings of Rapley *et al.,* (2009); Ritchie *et al.,* (2004); Ai-Leen and Jin Song, (2000). We have evaluated the effectiveness of Inzecto mosquito trap. The mean larval density of four INZECTO traps/week was 12.125, 26.375, 19.375 and 59.5 that is huge in number and indicating the reliability of using it as surveillance tool similar statements were also reported by Sasmita *et al.,*(2021); Wu *et al.,* (2013); Jahan and Sajjad Sarwar, (2013). We strategically placed four Inzecto mosquito traps in different environments to determine the preferred egg-laying habitat of

Table 3. The result of Post-hoc Tukey's test of larval density of *Aedes albopictus* per INZECTO trap in relation to different vegetation

Vegetation	Mean difference	Sig.
Large trees vs Large and dense grasses	-14.25000*	.000
Large trees vs Small grasses	-7.25000*	.000
Large trees vs Large trees and dense large grasses	-47.37500*	.000
Large and dense grasses vs Small grasses	7.00000*	.000
Large and dense grasses vs Large trees and dense large grasses	-33.12500*	.000
Small grasses vs Large trees and dense large grasses	-40.12500*	.000

*The mean difference is significant at the 0.05 level.

Table 4. Biological effects of IGRs Pyriproxyfen on developmental stages of *Aedes spp*

IGR	Concentration (ppm)	No. of larvae collected	Larval mortality (%)	Pupa emerged	No. of adult emerged
Pyriproxyfen	0.31	86	7%	13	0

mosquitoes. The study revealed a clear and statistically significant association between vegetation type and the average larval density of *Aedes albopictus*. The one-way ANOVA results (F (3,28) =1107.109, p<.001) confirmed significant differences in mean larval density across the various vegetation groups. Specifically, areas with "Large trees and dense large grasses" exhibited the highest mean larval density (approximately 60), suggesting these environments provide optimal breeding habitats for *Aedes albopictus*. This is likely due to the combination of shade, moisture retention, and accumulation of organic matter that can serve as larval food sources.

The post-hoc Tukey's HSD test further delineated these relationships, showing statistically significant differences in all pairwise comparisons (p<.001). "Large trees" alone had the lowest larval density (approximately 12.5), while "Large and dense grasses" (approximately 27) and "Small grasses" (around 20) showed intermediate densities. The significantly lower larval density in areas with only large trees compared to areas with dense grasses or a combination of trees and dense grasses highlights the importance of ground-level vegetation in supporting *Aedes albopictus* larval development that coincides with the findings of Dalla Pozza and Majori, (1992); Lin *et al.,* (2016); Chen *et al.,* (2005) and contradicts to the statement provided by Cianci (2015) who found no positive relationship between dense vegetation and the presence of *Aedes albopictus* larvae. These findings emphasize the critical role of vegetation management in mosquito control strategies, particularly in urban and suburban environments where such habitats are prevalent.

The examination of the biological effects of the IGR pyriproxyfen on *Aedes spp.* developmental stages demonstrated its efficacy in disrupting the mosquito life cycle. Exposure of *Aedes spp.* larvae to a concentration of 0.31 ppm of pyriproxyfen resulted in a low larval mortality rate of 7%. However, the significant impact was observed in the subsequent developmental stages: only 13 pupae emerged from all larvae and 0 adult were emerged from pupae. Even at lower concentration of the pyriproxyfen effectively prevented emergence of adult *Aedes spp.* mosquitoes, making it a promising and safe tool for larval control, making it a valuable and safe tool for larval control and similar statements were reported by Kamal and Khater, (2010); Maoz *et al.,* (2017); Hustedt *et al.,* (2020). Furthermore, applying Pyriproxyfen at 0.31 ppm concentration in the trap are safe for both humans and aquatic life.

CONCLUSION

This study emphasizes the importance of advanced Aedes mosquito surveillance and control for dengue management in the absence of vaccines or effective treatments. The study concluded that among three tested ovitraps, Gravitrap and Inzecto Mosquito trap are more effective than BG-GAT for using as mosquito surveillance tool. "Large trees and dense large grasses" are identified as optimal breeding sites for *Aedes albopictus*, suggesting the need for targeted vegetation management. The pyriproxyfen is effective as IGRs to prevent the moulting from larvae to adult. Therefore, the larval Inzecto mosquito trap and adult Gravitrap are recommended as valuable surveillance tools for household-level dengue control in Bangladesh, facilitating mass trapping and monitoring of the dengue vector population. Integrating these traps into surveillance systems and regularly monitoring dengue vectors can help to predict dengue outbreaks. Furthermore, linking data from field-caught *Aedes* mosquitoes from ovitraps with Geographic Information Systems (GIS) and geostatistical method could enable the creation of mosquito density maps, assisting public health authorities in developing localized prevention and control programs, especially in high-dengue incidence areas.

LITERATURE CITED

AI-LEEN, G. T. and JIN SONG, R. 2000. The use of GIS in ovitrap monitoring for dengue control in Singapore.

BASHAR, K., MAHMUD, S., TUSTY, E. A. and ZAMAN, A. B. 2020. Knowledge and beliefs of the city dwellers regarding dengue transmission and their relationship with prevention practices in Dhaka city, Bangladesh. *Public Health in Practice*, **1**, DOI:100051.

BASHAR, K., SAMSUZZAMAN, M., ULLAH, M. S. and IQBAL, Z. H. 2005. Surveillance of dengue vectors mosquito in some rural areas of Bangladesh.

BASHAR, K., TUNO, N., AHMED, T. U. and HOWLADER, A. J. 2013. False positivity of circumsporozoite protein (CSP)–ELISA in zoophilic anophelines in Bangladesh. *Acta tropica*, **125**(2): 220-225. DOI: 10.1016/j.actatropica.2012.10.004.

CHAN, K. L. 1972 the eradication of Aedes aegypti at the Singapore Paya Lebar international airport. In *Vector Control in Southeast Asia. Proceedings of the 1st SEAMEO-TROPMED Workshop*, pp.85-88.

CHEN, C. D., BENJAMIN, S., SARANUM, M. M., CHIANG, Y. F., LEE, H. L., NAZNI, W. A. and SOFIAN-AZIRUN, M. 2005. Dengue vector surveillance in urban residential and settlement areas in Selangor, Malaysia. *Tropical biomedicine*, **22**(1): 39-43.

CIANCI, D., HARTEMINK, N., ZEIMES, C. B., VANWAMBEKE, S. O., IENCO, A. and CAPUTO, B. 2015. High resolution spatial analysis of habitat preference of Aedes albopictus (Diptera: Culicidae) in an urban environment. *Journal of medical entomology*, **52**(3): 329-335.

DA COSTA, C. F., DOS PASSOS, R. A., LIMA, J. B. P., ROQUE, R. A., DE SOUZA SAMPAIO, V., CAMPOLINA, T. B. and PIMENTA, P. F. P. 2017. Transovarial transmission of DENV in Aedes aegypti in the Amazon basin: a local model of xenomonitoring. *Parasites & vectors*, **10**: 1-9.

DALLA POZZA, G. and MAJORI, G. 1992. First record of Aedes albopictus establishment in Italy. *Journal of the American Mosquito Control Association*, **8**(3):318-320. DOI:10.1016/j.puhip.2020.100051.

FLORES-SUAREZ, A. E., PONCE-GARCIA, G., LOPEZ-MONROY, B., VILLANUEVA-SEGURA, O. K., RODRIGUEZ-SANCHEZ, I. P., ARREDONDO-JIMENEZ, J. I. and MANRIQUE-SAIDE, P. 2016. Aedes aegypti (Diptera: Culicidae) from Mexico. *Insecticides resistance*, p.99.

HUSTEDT, J. C., BOYCE, R., BRADLEY, J., HII, J., and ALEXANDER, N. 2020. Use of pyriproxyfen in control of Aedes mosquitoes: A systematic review. *PLoS neglected tropical diseases*, **14**(6): e0008205.

JAHAN, N. and SAJJAD SARWAR, M. 2013. Field Evaluation of Lethal Ovitraps for the Control of Dengue Vectors in Lahore, Pakistan. *Pakistan Journal of Zoology*, **45**(2).

KAMAL, H. A. and KHATER, E. I. 2010. The biological effects of the insect growth regulators; pyriproxyfen and diflubenzuron on the mosquito Aedes aegypti. *J Egypt Soc Parasitol*, **40**(3): 565-574.

LE GOFF, G., BOUSSÈS, P., JULIENNE, S., BRENGUES, C., RAHOLA, N., ROCAMORA, G. and ROBERT, V. 2012. The mosquitoes (Diptera: Culidae) of Seychelles: taxonomy, ecology, vectorial importance, and identification keys. *Parasites & Vectors*, **5**:1-16.

LIN, C. H., WEN, T. H., TENG, H. J. and CHANG, N. T. 2016. The spatio-temporal characteristics of potential dengue risk assessed by Aedes aegypti and Aedes albopictus in high-epidemic areas. *Stochastic Environmental Research and Risk Assessment*, **30**: 2057-2066.

MAOZ, D., WARD, T., SAMUEL, M., MÜLLER, P., RUNGE-RANZINGER, S., TOLEDO, J. and HORSTICK, O. 2017. Community effectiveness of pyriproxyfen as a dengue vector control method: A systematic review. *PLoS neglected tropical diseases*, **11**(7): e0005651.

MARTIN, E., MEDEIROS, M. C., CARBAJAL, E., VALDEZ, E., JUAREZ, J. G., GARCIA-LUNA, S. and HAMER, G. L. 2019. Surveillance of Aedes aegypti indoors and outdoors using Autocidal Gravid Ovitraps in South Texas during local transmission of Zika virus, 2016 to 2018. *Acta tropica*, **192**: 129-137.

MONTENEGRO, D., MARTINEZ, L., TAY, K., HERNANDEZ, T., NORIEGA, D., BARBOSA, L. and RAMÍREZ, J. D. (2020). Usefulness of autocidal gravid ovitraps for the surveillance and control

of Aedes (Stegomyia) aegypti (Diptera: Culicidae) in eastern Colombia. *Medical and Veterinary Entomology*, **34**(4): 379-384.

OBREGÓN, J. A., XIMENEZ, M. A., VILLALOBOS, E. E. and DE VALDEZ, M. R. W. 2019. Vector mosquito surveillance using centers for disease control and prevention autocidal gravid ovitraps in San Antonio, Texas. *Journal of the American Mosquito Control Association*, **35**(3):178-185.

PERICH, M. J., KARDEC, A., BRAGA, I. A., PORTAL, I. F., BURGE, R., ZEICHNER, B. C. and WIRTZ, R. A. 2003. Field evaluation of a lethal ovitrap against dengue vectors in Brazil. *Medical and veterinary entomology*, **17**(2): 205-210.

RAPLEY, L. P., JOHNSON, P. H., WILLIAMS, C. R., SILCOCK, R. M., LARKMAN, M., LONG, S. A. and RITCHIE, S. A. 2009. A lethal ovitrap-based mass trapping scheme for dengue control in Australia: II. Impact on populations of the mosquito Aedes aegypti. *Medical and veterinary entomology*, **23**(4): 303-316.

REGIS, L., MONTEIRO, A. M., MELO-SANTOS, M. A. V. D., SILVEIRA JR, J. C., FURTADO, A. F., ACIOLI, R. V. and SOUZA, W. V. D. 2008. Developing new approaches for detecting and preventing Aedes aegypti population outbreaks: basis for surveillance, alert and control system. *Memórias do Instituto Oswaldo Cruz*, **103**: 50-59.

RITCHIE, S. A., LONG, S., SMITH, G., PYKE, A. and KNOX, T. B. 2004. Entomological investigations in a focus of dengue transmission in Cairns, Queensland, Australia, by using the sticky ovitraps. *Journal of medical entomology*, **41**(1): 1-4.

RUEDA, L. M. 2004. Pictorial keys for the identification of mosquitoes (Diptera: Culicidae) associated with dengue virus transmission. *Zootaxa*, **589**(1): 1-60.

SASMITA, H. I., NEOH, K. B., YUSMALINAR, S., ANGGRAENI, T., CHANG, N. T., BONG, L. J. and TU, W. C. 2021. Ovitrap surveillance of dengue vector mosquitoes in Bandung city, West Java province, Indonesia. *PLoS neglected tropical diseases*, **15**(10): e0009896.

TAN, C. H., WONG, P. S. J., LI, M. Z. I., VYTHILINGAM, I. and NG, L. C. 2011. Evaluation of the dengue NS1 Ag Strip® for detection of dengue virus antigen in Aedes aegypti (Diptera: Culicidae). *Vector-Borne and Zoonotic Diseases*, **11**(6): 789-792.

VOGE, N. V., SÁNCHEZ-VARGAS, I., BLAIR, C. D., EISEN, L. and BEATY, B. J. 2013. Detection of dengue virus NS1 antigen in infected Aedes aegypti using a commercially available kit. *The American journal of tropical medicine and hygiene*, **88**(2): 260.

WU, H. H., WANG, C. Y., TENG, H. J., LIN, C., LU, L. C., JIAN, S. W. and WU, H. S. 2013. A dengue vector surveillance by human population-stratified ovitrap survey for Aedes (Diptera: Culicidae) adult and egg collections in high dengue-risk areas of Taiwan. *Journal of medical entomology*, **50**(2): 261-269.

ZEICHNER, B. C. and PERICH, M. J. 1999. Laboratory testing of a lethal ovitrap for Aedes aegypti. *Medical and veterinary entomology*, **13**(3): 234-238.