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EFFECTIVENESS OF THREE OVITRAMP DESIGNS FOR VECTORAL CONTROL OF AEDES AEGYPTI (DIPTERA-CULICIDAE)

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Abstract: *Aedes* (*Stegomyia*) *aegypti* (Linnaeus, 1762) and *Aedes* (*Stg*) *albopictus* (Skuse, 1894) are the most invasive and transmitting species. Entomological surveillance using ovitraps identifies vector species, population density and geographic distribution. The efficacy of three ovitrap designs for vector surveillance of *Aedes aegypti* was evaluated. Cross-sectional study with three designs of ovitraps made from recycled plastic bottles and painted black. **Design A,** one-liter container and fleece (F-1600) as oviposition substrate. **Design B,** four-liter container and filter paper cone as oviposition substrate. **Design C,** half-liter container, with cotton cloth as oviposition substrate. They were placed in ten houses in shaded and dark places. The substrates were immersed in water to activate embryogenesis, the 4th instar larvae were placed in 70% alcohol for identification. Statistical analysis was performed with the statistical program STATA v16. using Fisher's Exact and Kruskall Wallis test. A value of p <0.05 was significant. The ovitraps with the highest oviposition were A and C (p=0.002). Seven hundred eggs were collected, ovitrap A with 50.6%, C with 48.7% and B 0.7%. Hatched 18.7% of eggs, 100% of the larvae were *Aedes aegyti*. Ovitraps A and C showed greater oviposition, perhaps because they were small and had a porous substrate that allowed adhesion. The species identified was *Aedes aegypti*.

Keywords: ovitraps, vector surveillance, *Aedes aegypti*.

INTRODUCTION

About 3,000 species of mosquitoes have been reported worldwide. The family *Culicidae* includes two subfamilies, 11 tribes, 113 genera and 3,563 species (Reinert, et al., 2009). Vector-borne diseases account for more than 17% of infectious diseases, generating more than 700,000 deaths per year. They are caused by parasites, bacteria or viruses (WHO, 2023). *Aedes* (*Stegomyia*) *aegypti* (Linnaeus, 1762) and *Aedes* (*Stg*) *albopictus* (Skuse, 1894) are species of relevant interest for being among the most invasive and transmitters of viral diseases, frequently both species cohabit in the same region due to the separation of different habitats, competition or the environment that favors them (Rey and Lounibus, 2015). Arboviruses are a group of vector-borne viruses, presenting high morbidity and mortality rates in the population. In the last three decades, the presence and/or re-emergence of arboviruses is considered a threat to health worldwide. The increase in the geographical distribution of mosquitoes and viruses, mainly dengue virus (DENV), West Nile virus (WNV), chikungunya virus (CHIKV) and lately zika virus (ZIKV) put on alert that new epidemics may emerge at any moment (Young, 2018). In 2022, there was a considerable increase in the number of dengue cases and deaths in the Americas compared to previous years. Maintaining in the first weeks of 2023, with 2,809,818 cases of dengue with a cumulative incidence of 282.96 cases per 100,000 inhabitants, predominating with 75% (342,243) above Chikungunya and Zika (PAHO/WHO, 2023). The frontal attack on the vector is the most vulnerable traditional strategy (biological, chemical and physical) in the chain of transmission, reducing vector density in their immature stages, preventing oviposition, hatching, larval survival and preventing adults from reaching them. Entomological surveillance makes it possible to identify vector species, population density and geographical distribution in order to identify morphological characteristics, vector competence, susceptibility and resistance to control measures of *Aedes* in order to estimate the entomological and transmission risks of arboviruses in time and space. Ovitraps are inexpensive, are installed outside homes, are quickly distributed over large areas with non-specialized personnel, determine the distribution, vector abundance and measure the seasonal fluctuation of the population (PAHO/WHO, 2021; Balladares-Orellana, 2018). The objective of the present work was to evaluate the efficacy of three ovitrap designs and oviposition rates for vector surveillance of *Aedes aegypti*.

MATERIALS AND METHODS

During the summer of 2023, a cross-sectional study was conducted in Zumpango de Neri, municipality of Eduardo Neri, Guerrero, Mexico. The three ovitrap designs were made from recycled plastic bottles and painted black. **Design A** was a one-liter container, water was supplied covering three quarters of it and the upper quarter was covered with fleece (F-1600) as oviposition substrate (paper) (González-Olvera *et al.*, 2021). For **design B,** a four-liter container was used, with a cut in the middle 4 cm wide and 11 cm high, 1.5 liters of water was added and a 600 mL bottle with water was attached for replenishment, making a small hole in the base. A filter paper cone 13.5 cm in diameter and 8 cm high was added and supported by two wooden slats as oviposition substrate (Torres-Avendaño *et al.*, 2020). In **design C** a half liter container was **used**, two thirds of water was added and the upper third was placed with cotton cloth as oviposition substrate, two 4 cm holes under the rim to drain excess rainwater (Chanampa, 2019). After explanation and authorization from the dwellers, the three designs of ovitraps were placed in ten houses (Figure 1) in shady and dark places, in the peridomicile, out of reach of children and pets, where they remained for seven days (Figure 2), and were monitored daily to ensure their functioning. After the seven days, the ovitraps were removed and the substrates were immersed in water to activate embryogenesis in a transparent tray (Secretaría de Salud, 2015), for egg quantification, they were placed on 4 cm quadrant micas[2] . They were fed with meat meal and yeast (80:20), the 4th instar larvae were placed in 70% alcohol (González-Olvera, *et al.*, 2021). Identification was carried out with a stereoscopic magnifying glass and optical microscope using the key of Ibáñez and Martínez (1994). The statistical analysis was performed with the statistical program STATA v16. Obtaining frequencies and percentages, median and percentiles, Fisher's Exact test was applied. A p value <0.05 was significant.

Figure 1. Ovitrap designs. A) ovitrap with 1 liter container, B) ovitrap with 4 liter container and C) 500 mL ovitrap.

Figure 2. Distribution of houses with ovitraps.

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Figure 3. Quantification of eggs.

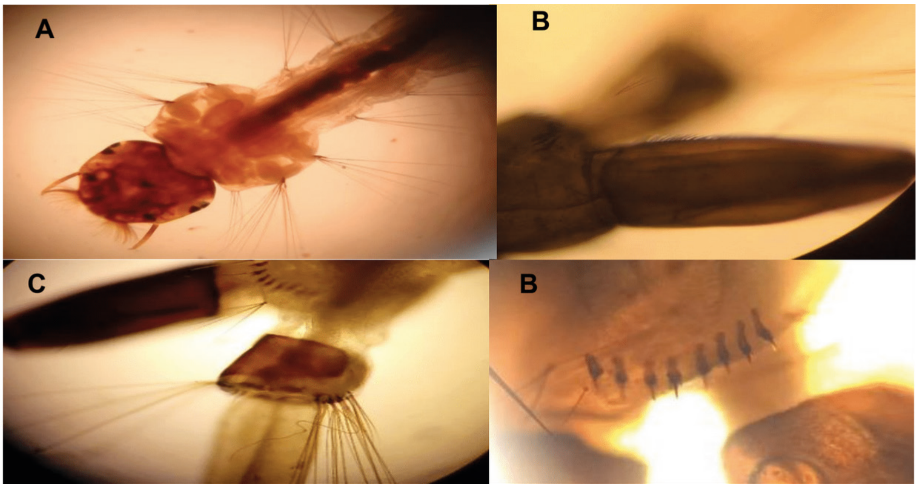

Figure 4. Morphological characteristics of Aedes aegypti larvae. A) Dorsal view, hooked dorsal spines and segmented abdomen. B) Lateral view of the terminal portion, incomplete anal sclerite and comb of the eighth abdominal segment. C) Siphon more or less cylindrical, never pointed with spines, with precratal hairs.

RESULTS AND DISCUSSION

Standard ovitraps have proven to be an effective method to detect the presence of gravid females and are widely used in entomological surveillance systems, as well as to evaluate the effectiveness of vector control measures. However, their implementation requires logistics, as they must be checked weekly. If this review is not carried out, ovitraps can become additional breeding sites, compromising their effectiveness as a control tool (Torres-Estrada and Rodiles-Cruz , 2013).

The ovitrap designs that presented the highest oviposition were A and C (Figure 3), showing significant differences between the models (Table 1), obtaining 70% positive. A total of 700 eggs were collected, ovitrap A presented 50.6%, design C, 48.7% and design B, 0.7% (Table 2). Hatched 18.7% of eggs, after identification, 100% of the larvae were *Aedes aegypti, (*Figure 4), Torres-Estrada and Rodiles-Cruz in 2013, reported higher frequencies in the comparison of two ovitraps (A= 65% and B= 35%), showing differences between them (p<0.0001); meanwhile, Alarcón, et al., 2014, evaluated 519 ovitraps, in which 76.4% were positive for *Aedes aegypti* eggs, showing that most species correspond to *Aedes aegypti.*

	Total	Design A	Design B	Design C	*p*
Eggs	2 (-26)	11 (0-29)	0 (0-1)	6 (3-86)	**0.0022**

Oviposture by ovitrap design.

No	Design					
	A		B		C	
	Eggs					
	n=354	50.6%	n= 5	0.7%	n=341	48.7%
1	29	8.2	0	0	2	0.6
2	110	31.1	0	0	29	8.5
3	0	0	1	20	5	1.5
4	0	0	0	0	86	25.2
5	26	7.3	2	40	3	0.9
6	1	0.3	0	0	106	31.1
7	166	46.9	0	0	4	1.2
8	1	0.3	1	20	2	0.6
9	0	0	0	0	7	2.0
10	21	5.9	1	20	97	28.4

Table 1. Oviposture by ovitrap design.

p=0.002*

*Fisher's exact

Regarding the oviposition indexes, the positivity index was higher in the ovitrap design C (100%), followed by A (70%); the average egg density per ovitrap was higher in design A (35.4%) and C (34.3%), finally the egg density index was higher for design A (50.6%) followed by C (34.1%) (Table 3).3%), finally the egg density index was higher for design A (50.6%) followed by C (34.1%) (Table 3), Torres, 2020 reported a positivity index of 0-60% for design A and 15-40% for design C; while Norzahira et al (2011), report positivity ranges of 8-47% and 30-78%, respectively. The egg density index was similar (41%) to that found by Ruiz, et al., 2018.

Oviposition rates by ovitrap design.

Design by ovitrampa	IPO	PDH	IDH
	%	%	%
A	70	35.4	50.6
B	40	0.5	1.2
C	100	34.1	34.1

IPO: positivity index

PDH: average density of eggs per ovitraps.

HDI: egg density index

CONCLUSIONS

The females of *Aedes aegypti* mosquitoes had a predilection for ovitrap designs A and C, which presented greater oviposition, perhaps because they were small containers and porous substrate that allowed their adhesion. The species identified was *Aedes aegypti*.

REFERENCES

Alarcón, Érika Patricia, Segura, Ángela María, Rúa-Uribe, Guillermo, & Parra-Henao, Gabriel. (2014). Evaluación de ovitrampas para vigilancia y control de *Aedes aegypti* en dos centros urbanos del Urabá antioqueño. *Biomédica*, *34*(3), 409-424. https://doi.org/10.7705/biomedica.v34i3.2134

Balladares Orellana, M. P. (2018). Diseño de ovitrampa para diagnóstico y control de vectores *Aedes aegypti*. Caso de estudio. *Instituto Nacional de Investigación en Salud*. http://repositorioslatinoamericanos.uchile.cl/handle/2250/2971170

Chanampa, M. d. M. (2019). Distribución y abundancia de *Aedes aegypti* en la provincia de Salta: asociación con factores ambientales. Tesis de doctorado, Universidad Nacional de Córdoba.

González Olvera G, Morales Rodríguez M, Bibiano Marín W, Palacio Vargas J, Contreras Perera Y, Martín Park A, *et al.* (2021) "Detección de *Aedes* (Stegomyia) *albopictus* (Skuse) en ovitrampas en Mérida, México," *Biomedica: revista del Instituto Nacional de Salud*, 41(1).

Ibañez Bernal, S. & Martínez Campos, C. (1994). Clave para la identificación de larvas de mosquitos comunes en las áreas urbanas y suburbanas de la República Mexicana (Diptera: Culicidae). *Folia Entomol.* Mex. 92. 43. Disponible en: https://www.researchgate.net/publication/236684912.

Norzahira R;Hidayatulfathi O;Wong HM;Cheryl A;Firdaus R;Chew HS;Lim KW;Sing KW;Mahathavan M;Nazni WA;Lee HL;Vasan SS;McKemey A;Lacroix R. (2024). Ovitrap surveillance of the dengue vectors, Aedes (Stegomyia) aegypti (L.) and Aedes (Stegomyia) albopictus Skuse in selected areas in Bentong, Pahang, Malaysia. Tropical Biomedicine, 28(1). Retrieved from https://pubmed.ncbi.nlm.nih.gov/21602768/

Organización Mundial de la Salud. Enfermedades transmitidas por vectores. 11 de noviembre de 2023. https://www.who.int/es/news-room/fact-sheets/detail/vector-borne-diseases#

Organización Panamericana de la Salud / Organización Mundial de la Salud. Métodos de vigilancia entomológica y control de los principales vectores en las Américas. Washington, D.C. OPS/OMS. 2021

Organización Panamericana de la Salud / Organización Mundial de la Salud. Actualización Epidemiológica: Dengue en la Región de las Américas. 28 de marzo de 2023. Washington, D.C. OPS/OMS. 2023

Reinert JF, Harbach R, Kitching IJ. (2009). Phylogeny and classification of tribe Aedini (Diptera: Culicidae). *Zool J Linn Soc.* 157(4): 700–94. https://doi.org/10.1111/j.1096- 3642.2009.00570.x

Rey, J. R. y Lounibos, P. (2015). Ecología de *Aedes aegypti* y *Aedes albopictus* en América y la transmisión de enfermedades. *Biomédica* [en línea]. 35(2).

Ruiz, N., Rincón, G. A., Parra, H. J., & Duque, J. E. (2018). Dinámica de oviposición de *Aedes* (Stegomyia) *aegypti* (Diptera: Culicidae), estado gonadotróficoy coexistencia con otros culícidos en el área Metropolitana de Bucaramanga, Colombia. Salud UIS, 50(4), 308–319. https://doi.org/10.18273/revsal.v50n4-2018004

Torres-Estrada y Rodiles-Cruz . Vista de Diseño y evaluación de una ovitrampa para el monitoreo y control de *Aedes aegypti*, principal vector del dengue. (2013). Retrieved November 26, 2024, from Saludpublica.mx website: https://www.saludpublica.mx/index.php/spm/article/view/7251/9458

Secretaría de salud. (2015). Guía Metodológica para la Vigilancia Entomológica con Ovitrampas. *Subsecretaría de Prevención y Promoción de la Salud.*

Torres Avendaño, J. I., Torres Montoya, E. H., Zazueta Moreno, J. M., Olimón Andalón, V., Romero Higareda, C., Salomón Soto, V. M., Flores López, B. A. y Castillo Ureta, H. (2020). *Índices Entomológicos de Ovitrampra y de Casa para Aedes aegypti en una zona rural de Sinaloa, México* [en línea].

Young, P. R. (2018). Arbovirus: una familia en movimiento. *Avances en medicina experimental y biología*. 1062, 1–10.