Journal of Communicable Diseases
Volume 57, Issue 1 - 2025, Pg. No. 79-84
Peer Reviewed & Open Access Journal

Research Article

# Diversity and Distribution of the *Aedes* Vectors in the Coastal Sites of Puducherry, Southern India

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**DOI:** https://doi.org/10.24321/0019.5138.202509

## I N F O

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**How to cite this article:**
Velan I, Prasad P, Baskar V, Venkat V, Anil A, Ragupathi L. Diversity and Distribution of the *Aedes* Vectors in the Coastal Sites of Puducherry, Southern India. J Commun Dis. 2025;57(1):79-84.

Date of Submission: 2024-10-21
Date of Acceptance: 2025-02-12

## A B S T R A C T

*Introduction:* Dengue poses a significant public health challenge in Pondicherry. Understanding the distribution of *Aedes* mosquito populations is critical for devising and implementing effective vector control strategies.

*Methods:* This study aimed to measure the abundance of dengue vectors through entomological surveillance methods and to evaluate the potential for dengue virus transmission within the coastal regions of Pondicherry. An entomological survey was carried out across nine randomly selected localities within Puducherry, in and around the premises, during 2019–2020, covering 180 households monthly.

*Results:* The analysis for the Adult Premise Index, per man hour density, and correlation was calculated using the SPSS Version 16.0 for assessing significant findings. The study found that *Aedes* mosquitoes infested 24.9% of the 537 positive houses. The adult density of *Aedes* mosquitoes was 16.6 per 10 person-hours and the average number of mosquitoes per house was 0.27 per 10 man-hours. The per-person-hour density of *Aedes* mosquitoes varied from 8.0 to 23.7 and was more abundant during monsoon months. Similarly, the adult premise index of *Aedes* mosquitoes varied from 8.9 to 36.7 and did not differ significantly in various months. *Ae. aegypti* was the predominant dengue vector followed by *Ae. albopictus*, which was most prevalent in June and less prevalent in February.

*Conclusion:* The current study provides valuable baseline data on the abundance and distribution of dengue vectors in the coastal areas of Pondicherry. Continued entomological surveillance is necessary to monitor the effective of control measures and detect changes in vector abundance and distribution over time.

**Keywords:** Aedes, Dengue, Vector, Vector Density, Premise Index

## Introduction

Dengue constitutes a significant public health challenge as an emerging arboviral disease transmitted by the genus *Aedes* mosquitoes.[1] According to the World Health Organization (WHO), over 129 countries are now endemic to dengue. It is estimated that approximately 390 million dengue virus infections occur globally each year, with around 96 million manifesting clinically.[2] The period between 2018 and 2022 witnessed a total of 729,588 reported dengue cases along with 1,043 fatalities attributable to dengue virus infection within the country; specifically, Puducherry reported 6,553 cases and 9 fatalities.[3] Two well-known species, *Ae. aegypti* and *Ae. albopictus*, have been transmitting dengue fever, chikungunya, yellow fever and the Zika virus.[4,5] It is noteworthy that implementing vector control measures can significantly mitigate the transmission of three critical arboviruses: dengue, chikungunya, and Zika.[6] Previous studies documented the species diversity and potential breeding habitat of *Aedes aegypti* and *Aedes albopictus* at Puducherry Union Territory, India.[7] Another study showed that the urban and rural locality of Puducherry had an infestation of dengue vector abundance, diversity and immature infestation of *Ae. aegypti* and *Ae. albopictus*, it reflects that the immature indices can be used as an indicator of the abundance of the *Aedes* mosquitoes, serving as a supplement to assess the risk of Puducherry.[8] In November 2017, a notable infestation characterised by high vector density and immature stages of the tiger mosquito was reported in Echangadu, a coastal village in Puducherry. This case study emphasised that mitigating vector density through comprehensive health education and source reduction strategies is crucial for decreasing dengue risk among coastal populations.[9] In view of the changing ecological and environmental conditions, there is a need to continuously monitor and study the bionomics of disease vectors on a regular basis in the present context.[10] Female *Ae. aegypti* mosquitoes are responsible for transmit the dengue virus, efforts have been taken to collect adult female mosquitoes, which would be an essential input to dengue prevention.[11] Intermittent feeding and skip oviposition behaviour of *Ae. aegypti* mosquitoes are important factors in dengue transmission potential and immature population density.[12] With the evolving ecological and environmental conditions, there is a need to continuously monitor and study the bionomics of disease vectors on a regular basis in the current context. Even though only female mosquitoes are capable of virus transmission, targeted efforts to collect adult female specimens are critical to the prevention of dengue. Furthermore, the intermittent feeding and skip oviposition behaviour observed in *Ae. aegypti* mosquitoes constitute vital factors in evaluating the potential for dengue transmission and the density of immature populations. The current study reporting the first time at different coastal villages at Puducherry had adult vector density.

## Materials and Methods

### Study Site

The present study was conducted in the coastal area of the Puducherry district in India. Puducherry district is located between 11°46’ and 12°13’ North and 79°36’ and 79°53’ East. The entomological survey was carried out in nine randomly selected sites in Puducherry, namely Ganapathichettikulam, Kalapet, Pillaichvadi, Solainagar, Vaithikuppam, Kurusukuppam, Vambakirapalayam, Poornagkuppam and Nallavadu from May 2019 to April 2020 extensively in the coastal areas (Figures 1 and 2).

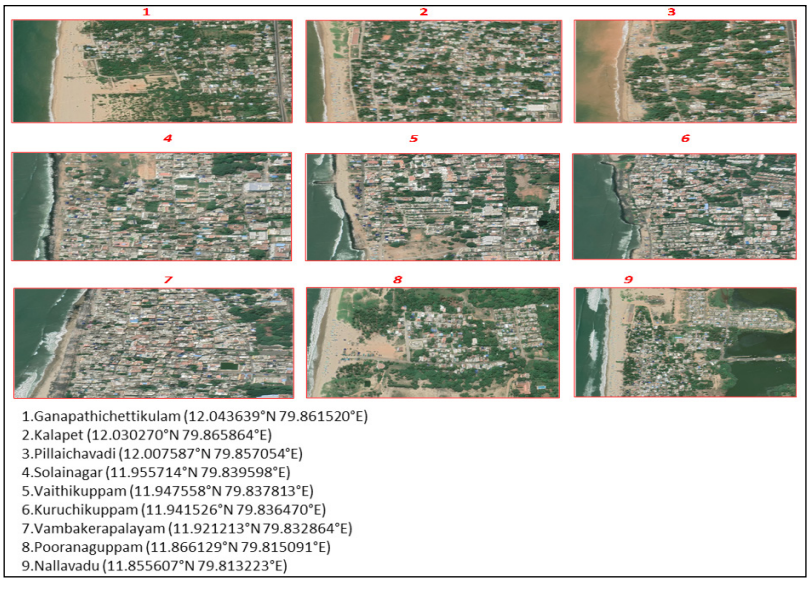


**Figure 1.A Map of Selected Study Sites in Puducherry, India**

**ISSN: 0019-5138**
**DOI: https://doi.org/10.24321/0019.5138.202509**

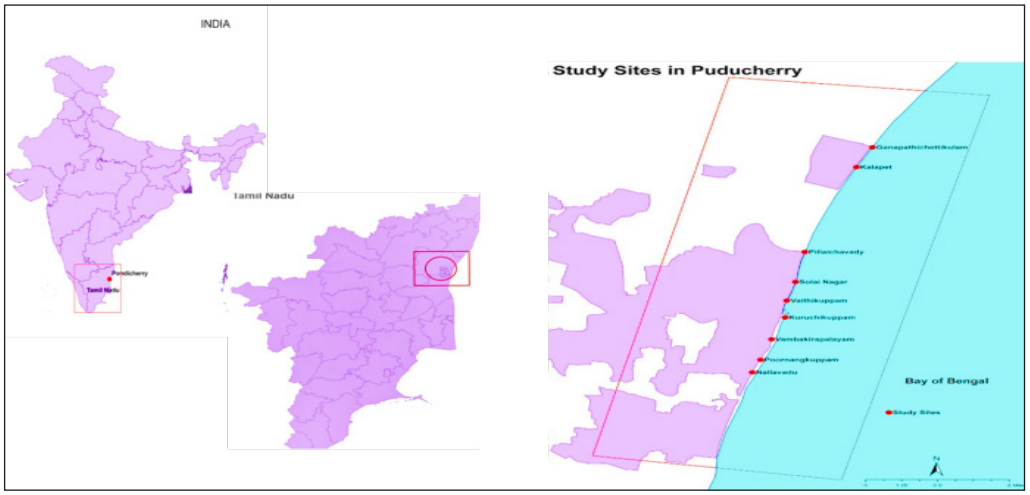


**Figure 2. Satellite Map Showing the Coordinate Positions of the Study Sites.26**

## Entomological Surveillance

The basic sampling unit for adult surveillance has been the house or premise. Systematic sampling was used to choose 180 households each month for a year. All mosquito resting places, such as clothes, curtains, furniture, storerooms, bedrooms and so on, were explored both inside (within the houses) and outside (outside the houses 10–20 m around the surrounding areas, including various domestic places) to collect female adult *Aedes* mosquitoes. In accordance with methodologies established in preceding studies, a hand net, mechanical/ oral aspirators, and a flash lamp were utilised to perform inspections within selected residences for 10 minutes in each dwelling during the early hours of day 5. Adult mosquitoes were collected and maintained in test tubes labelled with a location ID, house ID code, and collection date and preserved in polystyrene containing recyclable ice before being transported to the laboratory for identification using appropriate keys.[12]

No ethical approval was required for the study

## Data Analysis

Based on the standard identification key, the *Aedes* mosquitoes were identified and classified according to species and gender. Subsequently, the adult density was estimated using the Adult Premise Index (API, which is the number of positive residences for adult female *Aedes* mosquitoes divided by the number of examined houses multiplied by 100) and the per man-hour density (PMH, adult mosquitoes collected divided by total time spent in hours).

$$\text{API} = \frac{\text{No.of houses positive for adult female}}{\text{No.of houses inspected}} \text{x100}$$

$$\text{PMH} = \frac{\text{No.of Adult mosquito collected}}{\text{Total time spent in hours}} \text{x100}$$

The monthly meteorological data for temperature and rainfall was collected from the Department of Science, Technology and Environment, Government of Puducherry to calculate the correlation. The analysis was carried out using Excel spreadsheet 2013 and the SPSS supplied for assessing significance.

## Results

A total of 596 female *Aedes* mosquitoes were collected from 2,160 house units, spending 10 minutes in each house Table (1)

The adult density of *Aedes* mosquitoes was 16.6 per 10 man-hours (Table 1) while the average number of mosquitoes per house was 0.27 per 10 man-hours (PMH). The density of *Aedes* mosquitoes varied from 8.0 to 23.7 (Table 1) and was found more abundant during monsoon months but did not differ significantly ($p > 0.05$). Similarly, the API of *Aedes* mosquitoes varied from 8.9 to 36.7 (Table 1) and the difference did not show any significance in various months ($p > 0.05$).

**Table 1.Per 10 man hour density and Adult premise index of *Aedes* mosquitoes.**

| Month | Avg. Temp (°C) | Monthly rainfall (mm) | Houses examined | Positive houses | No.of *Aedes* mosq. Collected | Time spent in hours | Per man hour density | Adult premise index |
|---|---|---|---|---|---|---|---|---|
| May (2019) | 30.7 | 22.5 | 180 | 31 | 24 | 30 | 8 | 17.2 |
| Jun (2019) | 31.5 | 29.7 | 180 | 41 | 46 | 30 | 15.3 | 22.8 |
| Jul (2019) | 29.8 | 156 | 180 | 43 | 51 | 30 | 17 | 23.9 |

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202509

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Aug (2019) | 29.3 | 161 | 180 | 55 | 66 | 30 | 22 | 30.6 |
| Sep (2019) | 28.3 | 180.4 | 180 | 56 | 56 | 30 | 18.7 | 31.1 |
| Oct (2019) | 27.7 | 289.7 | 180 | 61 | 67 | 30 | 22.3 | 33.9 |
| Nov (2019) | 27 | 312.5 | 180 | 66 | 71 | 30 | 23.7 | 36.7 |
| Dec (2019) | 25.4 | 201.1 | 180 | 62 | 69 | 30 | 23 | 34.4 |
| Jan (2020) | 25.5 | 1.6 | 180 | 38 | 43 | 30 | 14.3 | 21.1 |
| Feb (2020) | 26.5 | 3.4 | 180 | 35 | 40 | 30 | 13.3 | 19.4 |
| Mar (2020) | 27.5 | 0.8 | 180 | 33 | 38 | 30 | 12.7 | 18.4 |
| Apr (2020) | 29.2 | 29.5 | 180 | 16 | 25 | 30 | 8.3 | 8.9 |
| Total | - | 1388.2 | 2160 | 537 | 596 | 360 | 16.6 | 24.9 |

*Per 10 man hour = adult mosquitoes collected/ total time spent X 10.

## Correlation of Monthly Rainfall and Temperature to Premise Index

There is a strong positive correlation ($r = 0.87$; $p < 0.5$) between the rainfall and API. As the rainfall increases in the month of August 2019 to December 2019, the API also increases (and vice versa). However, the temperature had a negative correlation ($r = 0.31$; $p < 0.5$) with the API as it remains almost the same throughout the whole year (Figure 3). A total of 360 man-hours were spent and 537 houses (24.8%) were found infested by *Aedes* mosquitoes (Table 1).

The results indicate that the risk of dengue transmission is throughout the year and in all the study areas. The study successfully collected three *Aedes* mosquito species (*Ae. aegypti, Ae. albopictus, Ae. vittatus*) from each surveyed location. Notably *Ae. aegypti Ae. albopictus* were prevalent all year and manifested as perennial species. *Ae. vittatus* demonstrated a seasonal dependency being only observed during the monsoon season. The analysis also revealed that, *Ae. aegypti* and *Ae. albopictus* were the predominant species accounting for 73% and 23%, respectively, of all adults collected, with only 4% belonging to *Ae. vittatus* (Table 2)

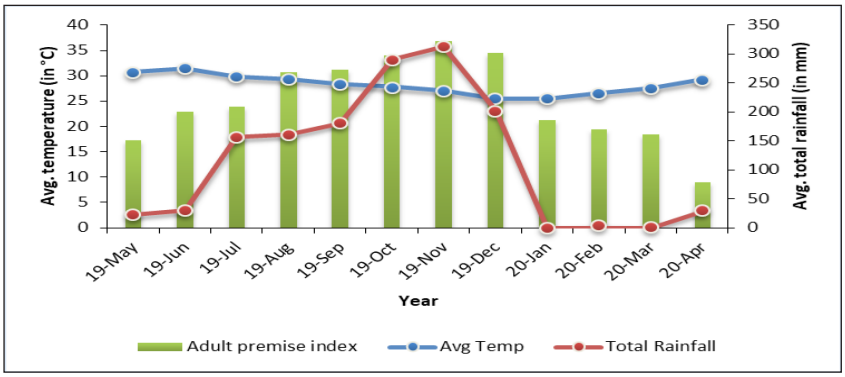


**Figure 3.Correlation of *Aedes* Mosquito Diversity with Monthly Rainfall and Temperature**

**Table 2.Village wise *Aedes* sp. Diversity**

| Name of Coastal Sites | No. of mos. Collected | Percentage of *Aedes* sp. Diversity | | |
|---|---|---|---|---|
| | | ***Ae.aegypti*** | ***Ae.albopictus*** | ***Ae.vittatus*** |
| Ganapathichettikulam | 87 | 0.66 | 0.32 | 0.02 |
| Kalapet | 69 | 0.68 | 0.30 | 0.01 |
| Pillaichavadi | 85 | 0.69 | 0.24 | 0.07 |
| Solainagar | 62 | 0.81 | 0.19 | 0.00 |
| Vaithikuppam | 68 | 0.71 | 0.29 | 0.00 |
| Kuruchikuppam | 46 | 0.74 | 0.26 | 0.00 |

**ISSN: 0019-5138**
**DOI: https://doi.org/10.24321/0019.5138.202509**

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|---|---|---|---|---|
| Vambakerapalayam | 59 | 0.95 | 0.05 | 0.00 |
| Pooranaguppam | 58 | 0.50 | 0.34 | 0.16 |
| Nallavadu | 62 | 0.92 | 0.06 | 0.02 |
| Total | 596 | 73 | 23 | 4 |

## Discussion

Dengue fever is a significant public health concern around the world.[13] In the absence of a vaccine, public health preventative measures aim to maintain a vector population density that is too low to permit continuous viral transmission because eradication is not practical.[14,15] Although an immature survey is essential, it must provide adequate disease transmission potential because only adults are responsible for disease transmission potency and blood-feeding ability toward susceptible hosts.[16,17] Moreover, adult mosquitos were collected, which is a potential technique for assessing the incidence of dengue transmission and provides critical scientific investigations.

Three *Aedes* mosquito species were observed in this study. *Ae. vittatus* was very rare, whereas Ae. aegypti, *Ae. albopictus* was abundantly reported throughout the year and was well established in these localities as a permanent population with a higher percentage, denoting that, *Ae. aegypti* is the primary dengue vector of the study areas and indicates dengue fever infection throughout the year. Still, the possibility of infection may vary in different regions. Several other studies supported our study by attempting to find infestations based on adult mosquito surveillance.[18,19] This study confirmed that the density of adult female mosquitos is the best indicator of dengue occurrence and supported previous studies.[20,21]

This study assists in identifying areas where vectors are present and thus aids in vector control measures by preventing the early spread of mosquitoes through various vector surveillance technologies. Other studies have found that climatic factors significantly impact dengue transmission and that dengue incidence increases during the rainy season.[22,23] However, rainfall was not found to be a determinant factor in this study because water storage was observed throughout the year due to scarcity of water, which is closely related to the abundance of vectors and thus increases the risk of dengue outbreaks, and similar findings have been found in other studies.[24] Viral evolution, unplanned urbanisation, rising population, international travelling, and population migration have all contributed to the spread of dengue. A continuous dengue surveillance system is the only way to reduce the severity of further dengue spread.[25] A system like this could show the spread of DENV and its serotypes over time and space in each Indian state. An adult vector population density indicator or measure that can forecast epidemic dengue transmission is needed for entomological surveillance. The study areas are predicted to be susceptible to dengue transmission due to the abundance of vector females, and an entomological risk exists in the Puducherry district.

## Conclusion

The current research and elucidation of species diversity have revealed that coastal villages in Pondicherry exhibit a notable presence of *Aedes* adults. These coastal regions are increasingly vulnerable to the propagation of arboviral infections, exacerbated by shifting climatic dynamics and alterations in land utilisation patterns. Environmental condition variations along the coastlines create opportune niches for several mosquito species, facilitating their establishment in these localities. Consequently, it is imperative to implement continuous monitoring and surveillance of vector populations, thereby enabling early warning systems and the decrease of arboviral disease risk.

## Acknowledgements

We thank all the laboratory attendants and technicians for their contribution in assisting investigations.

### Authors' Contribution:

IV- Validation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing and Supervision. PP- Methodology, Investigation, Formal analysis, Writing – original draft. VB- Methodology, Formal analysis. VV- Methodology, Formal analysis, Writing – Review & Editing AA- Methodology, Formal analysis, Validation, Resources, Data curation. LR- Methodology, Formal analysis, Data curation.

**Declaration of Generative AI and AI-Assisted Technologies in the Writing Process:** None

**Sources of Funding:** None

**Conflict of Interest:** None

## References

1. Gubler DJ. The global emergence/resurgence of arboviral diseases as public health problems. Arch Med Res. 2022;33(4):330-42. [PubMed] [Google Scholar]
2. World Health Organization [Internet]. Dengue and severe dengue; 2019 [cited 2024 Jan]. https://www.who.int/publications/i/item/ISSN-0250-8362.
3. NVBDCP [Internet]. [cited 2024 Jan]. https://ncvbdc.

mohfw.gov.in/
4. Angelini R, Finarelli AC, Angelini P, Po C, Petropulacos K, Silvi G Macini P, Fortuna C, Venturi G, Magurano F, Fiorentini C, Marchi A, Benedetti E, Bucci P, Boros S, Romi R, Majori G, Ciufolini MG, Nicoletti L, Rezza G, Cassone A. Chikungunya in north-eastern Italy: a summing up of the outbreak. Euro Surveill. 2007;12(11):E071122. [PubMed] [Google Scholar]
5. Tsetsarkin KA, Vanlandingham DL, McGee CE, Higgs S. A single mutation in chikungunya virus affects vector specificity and epidemic potential. PLoS Pathog. 2007;3(12): e201. [PubMed] [Google Scholar]
6. Malone RW, Homan J, Callahan MV, Glasspool-Malone J, Damodaran L, Schneider AD, Zimler R, Talton J, Cobb RR, Ruzic I, Smith-Gagen J, Janies D, Wilson J; Zika Response Working Group. Zika virus: medical countermeasure development challenges. PLoS Negl Trop Dis. 2016;10(3):e0004530. [PubMed] [Google Scholar]
7. Selvan PS, Jebnesan A, Kumar CM. Diversity and distribution of tree hole mosquitoes in Puducherry Union Territory, India. J Coast Life Med. 2015;3(7):531-3. [Google Scholar]
8. Jeelani S, Sabesan S. Dengue vector abundance and diversity of breeding habitats in Puducherry, South India. Trop Biomed. 2016;33(1):71-7. [PubMed] [Google Scholar]
9. Surendran V, Sahithyaa J, Arun S. Assessment of dengue mosquito breeding sources and source reduction at a coastal village in Puducherry. Int J Community Med Public Health. 2019;6(3):1035-8. [Google Scholar]
10. Nasci RS. A lightweight battery-powered aspirator for collecting resting mosquitoes in the field. Mosq News. 1981;41(4):808-11. [Google Scholar]
11. Iyyappan V, Vetrivel B, Asharaja AC, Shanthakumar SP, Reegan AD. Oviposition responses of gravid *Aedes aegypti* Linn. mosquitoes (Diptera: Culicidae) to natural organic infusions under laboratory condition. J Asia Pac Entomol. 2022;25(1):101853. [Google Scholar]
12. Romero-Vivas CM, Falconar AK. Investigation of relationships between *Aedes aegypti* egg, larvae, pupae, and adult density indices where their main breeding sites were located indoors. J Am Mosq Control Assoc. 2005;21(1):15-21. [PubMed] [Google Scholar]
13. World Health Organization (WHO). Global strategy for dengue prevention and control 2012-2020. WHO; 2012.
14. Sivagnaname N, Gunasekaran K. Need for an efficient adult trap for the surveillance of dengue vectors. Indian J Med Res. 2012;136(5):739-49. [PubMed] [Google Scholar]
15. Focks DA. A review of entomological sampling methods and indicators for dengue vectors. Dengue Bull. 2004; 28:223. [Google Scholar]
16. Bhat MA, Krishnamoorthy K. Entomological investigation and distribution of *Aedes* mosquitoes in Tirunelveli, Tamil Nadu, India. Int J Curr Microbiol Appl Sci. 2014;3(10):253-60. [Google Scholar]
17. Gomes AD, Silva NN, Bernal RT, Souza AD. Estimação da infestação predial por *Aedes aegypti* (Díptera: Culicidae) por meio da armadilha Adultrap. Epidemiol Serv Saude. 2008;17(4):293-300. Portugese. [Google Scholar]
18. Nguyen TP, Luu LL, Vu TQ, Buisson Y. [Increase of entomological indices during the pre-epidemic period of dengue in Ben Tre, South Vietnam. Bull Soc Pathol Exot. 2011;104(4):313-20. French. [PubMed] [Google Scholar]
19. Rodriguez-Figueroa L, Rigau-Perez JG, Suarez EL, Reiter P. Risk factors for dengue infection during an outbreak in Yanes, Puerto Rico in 1991. Am J Trop Med Hyg. 1995;52(6):496-502. [PubMed] [Google Scholar]
20. Lee HS, Nguyen-Viet H, Nam VS, Lee M, Won S, Duc PP, Grace D. Seasonal patterns of dengue fever and associated climate factors in 4 provinces in Vietnam from 1994 to 2013. BMC Infect Dis. 2017;17(1):218. [PubMed] [Google Scholar]
21. Xuan LT, Hau PV, Thu DT, Toan DT. Estimates of meteorological variability in association with dengue cases in a coastal city in northern Vietnam: an ecological study. Glob Health Action. 2014;7(1):23119. [PubMed] [Google Scholar]
22. Dibo MR, Chierotti AP, Ferrari MS, Mendonca AL, Neto FC. Study of the relationship between *Aedes* (Stegomyia) aegypti egg and adult densities, dengue fever and climate in Mirassol, state of São Paulo, Brazil. Mem Inst Oswaldo Cruz. 2008;103(6):554-60. [PubMed] [Google Scholar]
23. Bhat MA, Krishnamoorthy K, Khan AB. Entomological surveillance of dengue vectors in Tamil Nadu, India. J Entomol Zool Stud. 2014;2(6):158-64. [Google Scholar]
24. Kolivras KN. Mosquito habitat and dengue risk potential in Hawaii: a conceptual framework and GIS application. Prof Geogr. 2006;58(2): 139-54. [Google Scholar]
25. Cromwell EA, Stoddard ST, Barker CM, Rie AV, Messer WB, Meshnick SR, Morrison AC, Scott TW. The relationship between entomological indicators of *Aedes* aegypti abundance and dengue virus infection. PLoS Negl Trop Dis. 2017;11(3):e0005429. [PubMed] [Google Scholar]
26. Google earth. [cited 2019 may]. https://www.google.com/intl/en_us/earth/

**ISSN: 0019-5138**
**DOI: https://doi.org/10.24321/0019.5138.202509**