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PHYSICO-CHEMICAL CHARACTERISTICS OF BREEDING HABITATS AND ITS INFLUENCE IN LARVAL POPULATION DENSITY OF DENGUE VECTOR *AEDES AEGYPTI* IN THANJAVUR, TAMILNADU, INDIA

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ABSTRACT

The presence of suitable breeding habitats and the development of *Aedes aegypti* largely depend upon hydrology – driven ecological factors. The breeding habitats of *A. aegypti* were identified and characterized within the city corporation of Thanjavur, Taminadu, India, between January, 2016 and December, 2016. Breeding habitat such as waste bucket, over head tanks and discarded waste were identified and *A.aegypti* larvae were collected from the surveyed habitats. Physical parameters (pH, turbidity, conductivity, BOD, COD, dissolved oxygen, and total dissolved solids) were estimated. The relationship between the characteristics of breeding habitats and abundance of *A.aegypti* larva was investigated. pH was found to be positively related to larval abundance in all the three different habitats.

KEYWORDS: *Aedes Aegypti*, Breeding Habitats, Physicochemical Parameters

INTRODUCTION

Dengue, a fast spreading vector borne disease is endemic in more than 100 countries with half of world's population living in area at risk of this disease (Hartjes, 2011). Dengue fever infection is one of the most important arboviral diseases in humans (Guillena, *et al.,* 2010). It is endemic in Africa, America, Eastern Mediterranean, Southeast Asia and the Western Pacific, threatening more than 2.5 billion people. It is estimated that 50-100 million dengue infections occur each year (WHO, 2012). Outbreaks create a huge burden on population, health systems and economies in most tropical countries of the world. Dengue viruses are the causative agents of dengue fever and dengue hemorrhagic fever/dengue shock syndrome (DHF/DSS) in humans (Baba, and Talle, 2011). Vector control is shown to be effective against dengue transmission when applied early in the season (Stoddard, *et al*., 2014). In addition, there is growing evidence for vector adaption to outdoor breeding that can increase impact of the climate change on dengue (Chadee, *et al*, 2016; Manrique- Saide, *et al.,* 2012). Understanding the climatic diversity can improve not only disease surveillance and control in endemic areas, but also health efforts since tourists visit endemic countries on seasonal holidays (Wilder-Smith, *et al*., 2012). Several studies on dengue and climate have revealed the pivotal role of temperature on both the spread and seasonality of dengue. (Morin, *et al.*, 2013; Eisen, *et al.*, 2014). Rainfall mainly impacts dengue by generating physical conditions for the breeding of the vector. Rain water can stagnate into a natural breeding habitat or feed and artificial one where mosquitoes can lay eggs. On the other hand, rainfall intensity may have negative effects by pushing larvae down the water columns or washing them out farther from the breeding site or shortening the survival of adults. The adult *Aedes aegypti* prefers to rest indoors and feed on humans during daylight hours (Gubler, 1998). It's peak biting periods are early in the morning and before dark in the evening (Gubler, 1998). Once contacted with the virus, the mosquito remains infected during its entire life and may transmit the virus during blood meals (Figueiredo, *et al.*, 2012).

The viruses are maintained in an *Aedes aegypti* – human *Aedes aegypti* cycle with periodic epidemics (Gubler, 1998). Most females of *Aedes aegypti* may spend their lifetime in and around the houses were they emerge as adults (WHO, 2009). Urban areas with high density of water storage receptacles are suitable for breeding of A*edes* mosqutios (Kyle, *et al.,* 2003). In most of this area small number of *Aedes* breeding habitats exist even during the adverse month of the year and consistently serve as the primary producers of *Aedes aegypti*, referred as "Key containers" (Sinh, 2013) which are region specific for *Aedes* breeding (Salamat, *et al.*, 2013). Key containers in Phlipines inculed plastic and metal drums and plastic containers (Edillo, *et al*.,2012) wild its roof gutters in Astralia (Montgomery, 2002). In India cement tanks and plastic containers were identified as major breeding habitats of *Aedes aegypti* (Balakrishnan, *et al.*, 2006; Mondal, *et al*., 2014). In the capital city, Delhi, India over head tanks and curing tanks were identified as "Key containers" of *Aedes* breeding (Vikramkumar, *et al.,* 2015). Mosquito larvae are found in habitats possessing a wide range of physico chemical factors (Amarsingh and Dalpadado., 2014; Muthuri, *et al.*, 2008; Hamid, *et al*., 2009; Amerasinghe, *et al.*, 1995). Further, the mosquitoes in clear water with suitable pH, temperature and nutrient conditions have been found to thrive significantly (Russell, 1999). Diagnostic and scientific research has shown that many mosquito species prefer habitats without oxygen tension while some breed in open, sunlight pools (Okogyn, 2005). In general, water of a near neutral pH of 6.8 is preferable for breeding of many species of mosquitoes. Various chemical properties of the larval habitats observed in gutters, pre runoff and domestic areas are related to vegetation and a wide range of heavy metals, nutria physicochemical characteristics of the water, ranging from pH, optimum temperature, total suspended solids, total dissolved solids, electrical conductivity etc, have been found to affect larval development and survival (Mutero, 2004).

The present study has undertaken the surveillance of *Aedes aegypti* breeding habitats, assessment of the physiochemical properties and rain fall influencing larval population density in Thanjavur, Tamilnadu, India.

MATERIAL & METHODS

Study Area

The studies on the mosquito breeding habitats were conducted at Thanjavur, the head quarters of the Thanjavur District Tamilnadu, India. Thanjavur is situated in the eastern coast of Tamilnadu in the Cauvery Delta. It is an important agricultural centre and known as the "Rice bowl of Tamilnadu". In the present study, surveillance of *Aedes aegypti* with special reference to man-made breeding containers (waste bucket, over head tank and discarded waste) were conducted in various places within the city corporation of Thanjavur.

Larval Survey

The breeding habitats, waste bucket, over head tank and discarded waste were examined for the presence of mosquito larva. The surveys were carried out once in a month from January, 2016 to December, 2016.

Larval Density

The mosquito larvae were collected from the breeding habitats using a net (6cm width). The *Aedes aegypti* larval collections were recorded and the larval density was calculated using the following formula.

Larval density = Number of larval collected / Number of dips made.

Measurement of Water Quality Parameters

In order to assess the water quality characteristics of *Aedes aegypti* breeding sites, six parameters were considered in this study which include physicochemical parameters. A physical analysis of water in the breeding habitat was performed *in-situ*. The parameters involved are turbidity (NTU), pH, and dissolved oxygen (mg/L) by using appropriate instrument. The collected water samples were then further analysed for other parameters which include chemical oxygen demand (COD), biological oxygen demand (BOD) and total suspended solids (TSS) were estimated by standard methods APHA (2006).

Statistical Analysis

Means and Standard Deviations were calculated and compared by the one-way ANOVA. The multiple regression analysis was applied to examine the relation of the mosquito larval densities to the physico-chemical factors of the breeding water. The slopes (regression coefficients) of the regression equations were tested for deviation from zero by t-test. The SPSS software (Version 20 for windows, SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

Result

Aedes aegypti larval population densities in manmade containers were surveyed in Tanjavur city from January to December 2016. The variation in larval population density from different breeding habitats was illustrated in Figure 1. A total of 15,944 mosquito larva were collected from three different breeding habitats such as Overhead tanks, Waste Buckets, Discarded waste materials such as plastic cups, polythene bags, broken glass, tin cans and mineral water bottles. Waste Bucket was found to contain maximum number of larva (7895) followed by over head tanks (7616) and discarded waste (433).

A gradual decrease in larval population density in all the surveyed habitats was recorded from the month of January to May (Pre-monsoon). When there was complete absence of rainfall (Table: 1). In June 2016 the larval density increased more than 100%. Maximum larval density was recorded during September (94.27± 3.46) October 2016 (20.35±2.087) in Over Head Tank and Discarded waste breeding habitats and the maximum larval density in Waste bucket breeding habitat was recorded in June 2016 (90.91 ±4.29).The one way analysis of variance (ANOVA) gives the F Value 29.584 with P value < 0.05. Thus there is no significant difference between the larval densities among the three habitats.

The physiochemical characteristics of breeding habitat such as turbidity, total dissolved solids, pH, electrical conductivity, dissolved oxygen, BOD and COD were estimated (Table 2). Turbidity ranged from 9.8±0.63 to 14.9±0.70 in the breeding habitats. Dissolved oxygen ranged from 0.20±0.11 to 0.4±0.14 mg/ml. There was no significant difference in oxygen content between the water samples from different habitats. The electrical conductivity was found in the range of 1.0±0.3 to 1.3±0.03 dsm^{-1}. No significant difference in the turbidity of water in discarded waste and waste bucket breeding habitats were found. Over head tanks had a slight increase in turbidity compared to the other two breeding habitats (14.9±0.70). The variation of mean population density ranged from 32±3.22 to 94.27±3.46 in over head tanks, 23.66±3.55 to 90.91±4.29 in waste buckets and 1±1 to 20.33±2.08 in discarded waste. pH of different breeding habitats were in the range 7.2± 0.4 to 7.9±0.04. Waste Bucket container breeding habitat had a mean pH of 7.2± 0.04, Discarded Waste recorded 7.9±0.04 and overhead tank 7.5±0.04. The results indicate that the *Aedes* larva preferred slight alkaline pH. No significant difference were found in dissolved oxygen and electrical conductivity of all three breeding habitat.

The multiple regression analysis for the effect of physiochemical factors on densities of *Aedes aegypti* on the three breeding habitats revealed that electrical conductivity and BOD are indirectly related with Waste bucket breeding habitats and pH is directly related with all the three breeding habitats.

DISCUSSION

The selection of breeding sites is an important factor mosquito survival and population dynamics. These breeding habitats were influenced by many factors such as attractant and deterrents. Selections of oviposition site are linked with environmental factors such as rainfall, humidity, temperature and wind speed (O'Gower, 1963, Bentely and Jonathan, 1989). A study has shown that the larval habitat was influenced by physiochemical parameters that may affect the larval development and survival (Romeo et al., 2013). The different habitats in the present study showed differences in their physicochemical characteristics. Besides nutrition, pH plays an important role in the development and growth of mosquito larvae. Seghal and Pillar (1970) reported that *A. aegypti* and *A. albopictos* breed in identical sites in regard to pH. In general an increase in pH, salinity and alkalinity results in faster development of mosquito larvae (Umar and Donpedro, 2008). The pH above the range of 7 - 8 could be used as tool for mosquito control programme. Manmade containers and natural sites were preferred by *Aedes aegypti* mosquitoes. Female mosquitoes lay their eggs in domestic containers with a majority of discarded receptacles, water storage containers, tyres, wells, cement tanks and sinks (Dieng H. Saifur *et al*,. 2012). The population of dengue vector larvae depends on the size of the container and the presence of predators. The present study, characterized the *A. aegypti* breeding habitats by measuring the physiochemical factors of the container and reveals that the dengue vector preferred to breed in polluted water that had been stored for a long time. In the present study relation between physicochemical factor and larval abundance were identified. Waste Bucket was preferably chosen by *A. aegypti* as breeding habitats.

In India, Dengue infection occurs generally during or after rainy season with increase in vector population (Pandya 1982). Our results indicate high larval population density in the month of September and October followed by heavy rainfall. Similar results were also reported by Katyal *et al*., 2003 ; Rao, 1967; Thangamathi *et al*., 2011 and 2014.

Prevalence of *A. aegypti* larval density in Thanjavur had a direct impact over the incidence of Dengue cases. In conclusion the rainfall and physiochemical characteristic of breeding habitats had a significant influence on *A. aegypti* breeding sites and Waste buckets with long term storage of unused water and unmaintained overhead tank are preferred sites of breeding by *A. aegypti* mosquitoes. These preferences may be exploited to detect oviposition by *Aedes* mosquitoes.

Table 1: Collection of *Aedes aegypti* larvae from January, 2016 to December, 2016 in Thanjavur

	Monthly catches	Discarded Materials	Waste Bucket	Over Head Tank	Average rain fall
PREMONSOON	**January**	14±2.0	60.33±5.36	64.36±4.92	0
	February	1.6±0.57	29.41±2.77	32.81±4.49	0
	March	1.6±0.57	31.16±3.88	33.09±4.30	0
	April	1±1	23.75±3.57	32±3.22	0
	May	1±1	23.66±3.55	32.36±3.85	96.00
MONSOON	**June**	19.66±1.52	90.91±4.29	61.81±3.28	164.00
	July	18.66±2.08	63.41±4.25	70.72±2.28	94.00
	August	19±1	52.08±3.55	62.72±3.79	269.00

	September	19.66±1.52	83.50±4.40	94.27±3.46	239.00
POSTMON SOON	**October**	20.33±2.08	83.50±4.87	91.09±5.39	164.00
	November	19±1	74.16±5.39	73.18±4.40	43.60
	December	14±2.0	42±6.48	43.90±5.59	50.30

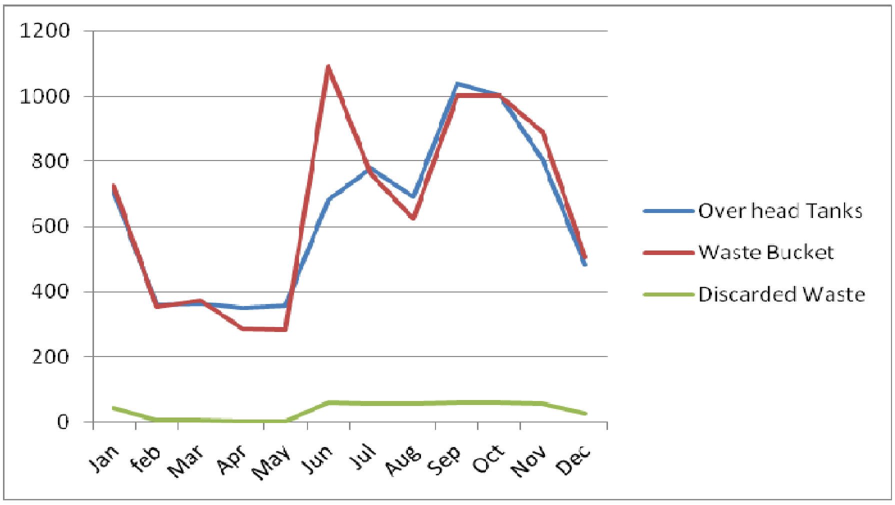

Figure 1: Larval Density of *Aedes Aegypti* During 2016

Table 2: Physicochemical Parameters of Different Breeding Habitats

PHYSICOCHEMICAL PARAMETERS	Discarded Materials	Waste Bucket	Over Head Tank
Turbidity	9.8±0.63	9.9±0.70	14.9±0.70
Total Dissolved solids (mg/l)	716±5.64	816±5.6	678±0.87
Ph	7.9±0.04	7.2±0.04	7.5±0.04
Electrical conductivity (dsm^{-1})	1.1±0.03	1.3±0.03	1.0±0.03
DO (mg/l)	0.2±0.11	0.3±0.14	0.4±0.14
BOD (mg/l)	121±6.13	161±6.13	153±6.13
COD (mg/l)	70.4±2.06	76.4±2.06	65.4±2.06

Table 3: Multiple Regression Analysis for the Effect of Physico-Chemical Factors of Breeding Water on Aedes Aegypti Larval Density

Physiochemical Paramaters	Waste Bucket		Over Head Tank		Discarded Waste	
	t	Sig.	t	Sig.	t	Sig.
Constant	-1.701	0.164	0.899	0.419	0.833	0.451
Turbidity	0.709	0.518	-0.436	0.685	-1.468	0.216
TDS	1.878	0.134	-1.214	0.291	-0.524	0.628
Ph	1.928	0.126	0.583	0.591	0.302	0.777
EC	-2.963	0.041	0.550	0.612	-1.523	0.202
DO	1.856	0.137	-0.600	0.581	0.669	0.540
BOD	-1.353	0.247	-1.607	0.183	-1.589	0.187
COD	1.009	0.370	-0.466	0.665	-0.129	0.904

REFERENCE

A. Umar, KN. Don pedro, The effects of p^H on the larvae of *Ae. Aegypti* and *Cx quinquefasciatus.* Int J Pure Appl Sci 2: 58-62, 2008.

1. A.K. Gower . Environmental stimuli and oviposition behavior of *Ae aegypti* var. queenslandis Theobald (Diptera : Culicidae). Anim behave 11: 189-197.
2. A.Wilder-Smith A. Dengue infections in travellers. Paediatr *Int Child Health* May;32 Suppl 1:28–32, 2012.
3. American Public Health Association (APHA). Standard methods for the examination of water and waste water. Washington, DC: APHA , 2006.
4. C.M. Mutero , *et al.*, Ammonium sulphate fertilizer increases larval population of *Anopheles arabiensis* and culicine mosquitoes in rice field. *Acta Trop* 2004: 89:187-92.
5. C.W. Morin *et al.*, Climate and dengue transmission: Evidence and implications. *Environ Health Perspect.* 2013;121(11–12):1264–72.
6. D. J. Gubler *et al.,*"Dengue and dengue hemorrhagic fever," Clinical Microbiology Reviews, vol. 11, no. 3, pp. 480–496, 1998.
7. D.D. Chadee *et al., Aedes aegypti* (L.) in Latin American and Caribbean region: With growing evidence for vector adaptation to climate change? *Acta Trop. Elsevier B.V*.; 2016;156:137–43.
8. D.J. Gubler *et al.*, Climate variability and change in the United States: Potential impacts on vector and rod at borne diseases. *Env Health prospective*, 109**(2)**:223, 2001 .
9. E.J Muturi , *et al* ., Environmental factors associated with the distribution of *Anopheles arabiensis* and *Culex quiquefasciatus* in a rice agro ecosystem in Mwea, Kenya. *J Vect Mosq* 2008; 33 (1) : 56-64.
10. F.E. Edillo *et al.*, The key breeding sites by pupal survey for dengue mosquito vectors, *Aedes aegypti* (Linnaeus) and *Aedes albopictus* (Skuse), in Guba, Cebu City, Philippines. *Southeast Asian Trop J Med. Public Health.* 2012; 43(6): 1365–1374.
11. F.P Amerasinghe, *et al.*, Physico-chemical characteristics of mosquito breeding habitats in an irrigation development area in Sri Lanka. *Cey J Sci (Bio Sci)* ;1995249(2):113-29.
12. G. Pandya "Prevalence of dengue infection in India", Defence Science Journal, Vol. 32, pp. 359-370, 1982.
13. G.R. Okogun *et al.*, Epidamological implications of preferences of breeding sites of mosquito species in Midwestern Nigeria. *Ann Agric Environ Med*, 10: 217-22.
14. H. Dieng *et al*. Unusual developing sites of dengue vectors and potential epidemiological implications. Asian Pacific *J Trop Biomed*. 2012; 2(3):228-232.
15. J. B. Guillena *et al.*, "Prevalence of dengue fever (DF) and dengue hemorrhagic fever (DHF): a description and forecasting," in Proceedings of the 11th National Convention on Statistics (NCS '10), p. 16, 2010.
16. J.L. Kyle, Global spread and persistence of dengue. *Annu Rev Microbio*l 2008;62:71–92.

17. L . Eisen *et al.*, The impact of temperature on the bionomics of Aedes (Stegomyia) aegypti, with special reference to the cool geographic range margins. *J Med Entomol*. 2014;51(3):496–516.

18. L.B. Hartjes, Preventing and detecting malaria infections. *Nurse Pract*.2011;36:45–53.

19. L.D. Amarasingh , Vector mosquito diversity and habitat variation in a semi urbanized area of Kelaniya in Sri Lanka. *Int J Entomol Res* 2014 ; 2(1):1521.

20. M. M. Baba *et al.*,"The effect of climate on dengue virus infections in Nigeria," *New York Science Journal, vol*. 4, no. 1, pp. 28–33, 2011.

21. M.D. Bentely, J.F. Day, Chemical ecology and behavioural Aspects of mosquito oviposition. Annu Rev Entomol 34;401-21, 1989.

22. M.S.S. Salamat, *et al.*, Entomological Survey of Artificial Container Breeding Sites of Dengue Vectors in Batasan Hills, Quezon City. Acta Medica Philippina. 2013;47(3): 63–68.

23. N. Balakrishnan, *et al.*,An entomology study on the dengue vector during outbreak of dengue in Tirupur town and its surroundings, Tamil Nadu, India. J Commun Dis. 2006; 38:164–168.

24. N. Sinh Vu, Key container and key premise indices for *Ae. aegypti* surveillance and control.In: Linda S. Lloyd editor. Best practices for dengue prevention and control in the Americas. Strategic Report;2013; pp.51-56.

25. P. Manrique-Saide *et al.,* Storm Sewers as Larval Habitats for *Aedes aegypti* and *Culex* Spp. in a Neighborhood of Merida, Mexico. *J Am Mosq Control Assoc.* 2012;28(3):255–7

26. P. Thangamathi, *et al.*, Physicochemical characteristics Malarial mosquito *Anopheles stephensi* habitats in relation to density at Kumbakonam, Taminadu, India. *Journal of Modern Science*. 3(2) 37-40.

27. P. Thangamathi, *et al.*, Seasonal variations and and physicochemical characteristics of the habitatats in relation to the density of Dengue vector *Aedes aegypti* in Thanjavur, Tamiladu, India.*International journal of Science and Nature.5(2) :271-276,* 2014 .

28. R. Katyal *et al.,* Impact of Intervention Measures on DF /DHF cases and *Aedes* 9 indices in Delhi, India 2003 : An Update,2001.*" Dengue Bulletin*, **27:**163-167

29. R. M. P. Figueiredo *et al.,* "Molecular characterization of dengue virus circulating in Manaus, the capital city of the state of Amazonas, Brazil," in *Current Topics in Tropical Medicine,* Rodriguez-Morales, Ed., chapter 6, pp. 81–90, InTech, Rijeka, Croatia, 2012.

30. R. Mondal *et al.,* Occurrence of *Aedes* mosquitoes (DIPTERA: CULICIDAE) in urban areas of doon valley, (Uttarakhand), INDIA. *Modern Parasitology*. 2014; 28:255–262.

31. R.C. Russell, constructed wetlands and mosquitoes: health hazards and management options-an Australian perspective.*Eco Engineering* 1999;12:107-24.

32. Romeo *et al.*,Modeling the complex hatching and development of *Aedes aegypti* in temperate climates. Eco Modeling, 2013; 253(4):44-55.

33. S.S. Seghal, M.K.K.Pillai, Preliminary studies on the chemical nature of mosquito breeding waters in Delhi. Bull WHO 42 : 647-50, 1970.

34. S.T. Stoddard *et al.*, Long-Term and Seasonal Dynamics of Dengue in Iquitos, Peru. *PLoS Negl Trop Dis*. 2014;8(7):19–21.

35. T.R Rao, Distribution, Density and seasonal prevalence of *Aedes aegypti* in the Indian sub-continent and south-east Asia. Bulletin of World Health Organization Vol 36, pp. 547-551,1967.

36. Vikram Kumar *et al.*, Comparison of *Ae*. *aegypti* breeding in localities of different socio-economic groups of Delhi, India. *International Journal of Mosquito Research* 2015; 2(2): 83–88.

37. WHO, Dengue Guidelines for Diagnosis, Treatment, Prevention and Control, WHO, Geneva, Switzerland, 2009

38. WHO, Global Strategy for Dengue Prevention and Control 2012–2020, WHO, Geneva, Switzerland, 2012.