

Review on surveillance and bionomics of (*Aedes* Mosquitoes) dengue vectors

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Abstract

Dengue is a serious vector borne viral disease in the tropical and subtropical region. Infection is caused by dengue viruses. Dengue has increased very fast in the last five decades. 50 to 100 million new dengue infections are reported globally every year. The lifespan of *Aedes* mosquitoes change depending on temperature and rainfall. The averages of lifespan of an *Aedes albopictus* can 19.1 days and 19.94 days for *Aedes aegypti* respectively. The dengue mosquitoes show anthropophilic endophilic and exophilic resting behavior and produce it a very effective vector of dengue, Chikungunya and Zika viruses. There are no specific antiviral medicines and defensive vaccine for dengue fever. However researchers are still working on finding a specific medicine or vaccine. The best way is prevention cure.

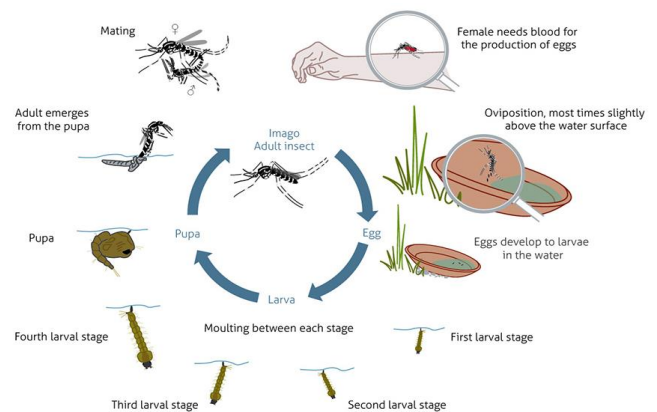
Keywords: tropical, infection, endophilic, exophilic, antiviral medicine, prevention

1. Introduction

Dengue is the serious mosquito borne viral disease in the world with about 2500 million people at risk in the world (WHO, 2017). *Aedes* mosquitoes also transmit Chikungunya, Yellow fever and Zika infections. Presently, there is no available valid antiviral medicine or defensive vaccine for dengue viral disease. (Xu *et al.*, 2016). Control of *Aedes* larva is the most effective process for controlling dengue viral disease. Change of global environment, urbanization, traffic, poor cleanliness and unequal public health are main factors which increase an adequacy of dengue transmission. (Kyle and Harris, 2008). Recent research has displayed that transmission of *Aedes* related to disease occurs within defined special and temporal type that depend on inadequate unequal level. Asian tiger mosquitoes and yellow fever mosquitoes are problems on almost all continents and are competent vectors in the western hemisphere for a number of various viruses including Chikungunya, dengue and Zika virus (Lance-parker *et al.*, 2002). Mosquitoes of *Aedes aegypti* were indicated to have circadian forms of variation in the behavioral aspects, such as locomotors activity, feeding and matting (Clements, 1999; Lima-camura *et al.*, 2014)^[1].

Shown the global circulation of *Aedes aegypti* and its concluded association with large scale climate events (Nicholls, 1993; Hales *et al.*, 1996)^[6, 5]. In such a situation, vector control is essential prevention tool organophosphates, insect's growth regulators and microbial control agents are usually focused using on mosquitoes larvae. Indoor residual spraying and insecticide treated bed nets are used to decrease in tropical areas (Lees *et al.*, 2014)^[4]. The adult's life period can range from two weeks to a month depending on environmental situation (Maricopa, 2006)^[11]. Most often, eggs will be placed at varying distance on inner wet walls of containers with waterline and will lay spread out the eggs over two or more sites (Foster and Walker 2002)^[10]. *Aedes* has evolved a survival process during the dry season; the eggs can enter a inactivity for up to 8 month at the end of embryogenesis (Diniz *et al.*, 2017)^[8]. During of metamorphosis a larva is a fully developed in the fourth

instars into a new formed called pupa in nearly 4 days, the cocoon stage for the mosquito. The life cycle stage of the mosquitoes occurs in the aquatic habitat. After 1-2 days, the fully evolved adult form and breaks through the skin of the pupae and a fully developed adult emerges. The adults mosquitoes are able to fly and a terrestrial habitat dwelling inside and outside households (Powell *et al.*, 2013)^[7]. Flowers of nectar or plant juices are used by male *Aedes* mosquitoes while the female that needs a blood meal (Whitehead *et al.*, 2007)^[9].



Source: awarenessofdenguessmktj.blogspot.com

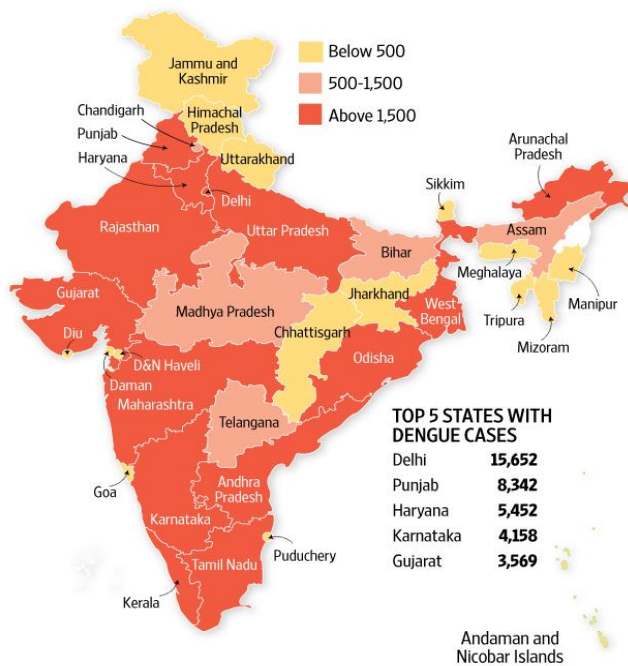
Fig 1: Life cycle of *Aedes* mosquito

2. Disease prevalence

In the recent past dengue fever is the very important viral disease influencing human that has one of the most important cause of morbidity and mortality in tropical and sub-tropical countries in the world. Majority of the global human population lives in the world of take a risk and in excess of 100 countries are experiencing dengue fever and dengue hemorrhagic fever epidemics in the early 21st century (Gha-sapir and Schimmer 2005)^[24]. Every year, there an estimated 50 to 100 million new dengue infectious recorded globally (Gubler, 1998 and 2004)^[21], of which

500,000 are DHF and 25000 are fatal (Gubler, (1998) [22]; Guzman and Kouri (2002) [25]; Guha-sapir and Schimmer (2005) [24]. Crai *et al.*, (1999) has noticed that from 32°C to 39°C temperature is high mortality in mosquitoes and at 40°C, mosquitoes daily survival becomes zero. The inter relationship between temperature and mosquitoes has been recently reviewed by (Dhiman *et al.*, 2008). Globally, 950 species of *Aedes* have been reported of which 115 species of *Aedes* in India. Distribution of dengue cases in India during is shown in Figure-2. Out of them two major vector for viral disease in India are *Aedes aegypti* and *Aedes albopictus*. Currently spreading of the invasive mosquito species, *Aedes koreicus* in northern Italy has been noticed by (Montarsi *et al.*, 2015) [34]. In India Das *et al.*, (2015) evaluate spatial distribution of *Aedes* mosquito with special point out to bionomics of *Aedes albopictus* subpopulation collected from different part of Odisha. The collection included of 70.1 % *Aedes albopictus*, 26.5% *Aedes aegypti*, 3.4% *Aedes vittatus* and 1.4% *Aedes edwardsii*. The percentage of male *Aedes* population 60.20% was greater than female, *Aedes* population 39.80% for all *Aedes* species.

DISTRIBUTION OF DENGUE CASES IN 2015*



*upto 21 November

Source: WHO, South Delhi Municipal Corporation, Ministry of Health and Family Welfare

Fig 2: Distribution of Dengue cases in India during 2015.

3. Resting behavior of *Aedes*

Aedes species are anthropophilic feed in the dark, the early in the morning time and display an indoor-resting behavior especially in separated stationary places e.g. under furniture, lower wall, sinks, in shutter folding and clothing (Liebman *et al.*, 2014) [32]. Exposed that *Aedes aegypti* rested generally below 1.5 meters of height and mostly in bedrooms (44%), living rooms (25%) and bathrooms (20%). *Aedes* species behave as platform between humans and human primates. This species have been found immature forms in forest area and strong performance for urban environmental region

(Dunibos *et al.*, 2003). The *Aedes aegypti* is broadly noted as day biting mosquitoes in the tropical region. This is major urban vector of dengue viruses is endophilic and has noticed habit of feeding and resting inside the house. *Aedes aegypti* exhibit a known preference for subject with the least view e.g. dark coloured object and areas out of form open space with milky light internal sites or with higher degree of shadow as their resting habitat (Sippelland Brown, 1953; Muir *et al.*, 1992) [43]. The attraction to different coloured surfaces by the mosquitoes are interconnected with the percentage of the light viewed rather than any colour distinction (Brown 1954) [43]. Brett (1938) [112] confirmed that *Aedes aegypti* mainly preferred dark coloured clothing exposing that black is the most attractive colour for *Aedes* species followed by red, which also has a such like low reflectance factor.

The colour White was avoided because of its high reflex factor. Otherwise, yellowish khaki showed to be more repellent than white and yellow both of which are repellent colours. There are many resting box methods preferred for sampling mosquito vector population as well as for surveillance and control plans (Morris, 1981; Crans, 1989; Nasci *et al.*, 1993; Edman *et al.*, 1997; Kittayapong *et al.*, 1997; Harbison *et al.*, 2008; Kweka *et al.*, 2009) [35, 37, 17]. The boxes have many kinds of shapes, colours and materials regulate to capture male and female *Aedes* mosquitoes indoor and outdoor (Yasuno *et al.*, 1976; Goodwin, 1942; Edman *et al.*, 1968; Morris, 1981; Kay, 1983; Weathersbee and Meisch, 1988) [36, 16]. Resting boxes patterned by Edman *et al.*, (1968) [16] and Morris (1981) [35] are e.g. of resting boxes that were particularly prepared for collecting blood fed adult *Culiseta melanura* as part of surveillance program for eastern equine encephalitis its virus and a study on *Aedes* mosquitoes richness flight range and dispersal (Howard *et al.*, 1989, 1996; Oliver *et al.*, 1996) [38, 41]. Dunn (1927) In Nigeria detected *Aedes aegypti* almost 500 feet (150 meter) from the dwellings sites, While Shannon and Davis (1930) was reported 1000 feet (305 meter) in deep sites. They were collected 4850, 5500 and 1200 specimen relearned, 38%, 56% and 23% respectively, were taken within 330 feet (100meter).

4. Biting behavior of *Aedes*

Aedes aegypti bites mainly during the day. This species is most active for generally two hours after sunrise and several hours before sunset, but it can bite at night in milky light *Aedes* mosquitoes can bite it coming from behind and bites dog and other domestic animals. *Aedes* mosquitoes can bite without being noticed because it coming from behind and bites on the ankles and elbows. These mosquitoes prefer biting people but it also bites dogs and other domestic animals, mainly mammals. Only females bite to get blood in order to lay eggs. The behavior of blood feeding *Aedes aegypti* has been studied by many workers and the literature has been reviewed by Christopher (1960) [13], Clements (1963) [14] and Marchux *et al.*, (1903) reported that under favorable conditions female *Aedes aegypti* was ready to bite shortly after emergence and in general did so readily after 24 hours. Gutzevich (1931) stated that at 28°C the first blood meal occurred usually 2-3 day after emergence. Seaton and Lumsden (1941) [42] used completely starved virgin females up to 6 days old on a human host and found few mosquitoes feeding when 1-2 days old. Seaton and Lumsden (1941) [42] & Bishop and Gilchrist (1946), in their

experiments fed nothing to their mosquitoes until they were used. Christopher says that some effect upon biting option was thought to result when *Aedes* mosquito had been previously allowed to feed sugar and fruit, even water shortly before the experiment.

5. Breeding habitat of *Aedes*

Maimusa *et al.*, (2016) worked on the life cycle of developmental attributes of laboratory colonies of wild types of *Aedes albopictus* and *Aedes aegypti* were studied and measured based on the age stage, two-six life cycle. The total pre-adult life cycle time was 9.47 days for *Aedes albopictus* and 8.76 days for *Aedes aegypti*. The lifespan was 19.01 days for *Aedes albopictus* and 19.94 days for *Aedes aegypti*. Mortality occurred mainly during the adult stage. The mean life cycle time for every stage slightly correlated with temperature for *Aedes albopictus* and *Aedes aegypti*. Female of *Aedes aegypti* move to oviposit in more than one site within the same ovi-position window, which may strategically increase the potential of living and dispersing when ideal ovi-position sites are not found (de Abreu *et al.*, 2015)^[2].

6. Seasonal prevalence of *Aedes*

Dengue is main public health problem for tropical and subtropical region of world's population and is increasing cause of hospitalization and death, mostly for children in endemic countries (Gubler, 2012)^[12]. Temperature has been increased by a global average of 0.75°C over the past 100 years as part of global climate change. Outside from climate factors other main issues that potentially use to global changes in dengue and distribution include population growth, as urbanization, lack of increased human travel, in effective mosquito control and increased reporting capacity (Githeko, 2012; Walker *et al.*, 2011; Thai and Anders, 2011; Pinto *et al.*, 2011)^[19, 10, 41]. People of all ages are affected by dengue including infants irrespective of gender. Cause of dengue is viruses a spectrum of disease with symptoms from mild influenza like symptoms to fatal hemorrhage fever (Halsted, 2007). The life cycle of *Aedes aegypti* is directly influenced by ambient temperature and rainfall (Shope, 2007). Increased temperature could increase risk and increasing the rate of mosquito's development and virus incubation time can reduce in areas where the vector directly exists, whereby increasing the rate of transmission (Fockset *et al.*, 1997; Kuno, 1995; Mc Michael and Haines, 1997; Patz *et al.*, 1996)^[40]. Thus the conditions of climate affect the virus the dengue vector and human behavior directly and indirectly (Gubler, 2001)^[13].

7. Conclusion

Dengue is the major public health problem for tropical and subtropical countries of the world's population. In the recent past dengue is a very important viral disease influencing humans that has one of the most important cause of morbidity and mortality in Asia, Africa, and Latin America with half population of world. Natural and manmade container of water can support *Aedes* mosquito's production. *Aedes* species are anthrophagite feed in the dark, the early in the morning approximately two hours after sunrise and several hours before sunset and display indoor – resting behavior especially in separated stationary places. Chikungunya, yellow fever and Zika infections are also transmitted by *Aedes* mosquitoes. There is no available

medicine or vaccine for dengue virus disease.

8. References

1. Clements AN. The biology of mosquito's sensory reception and be-haviour. London: Chapman and Hall, 1999, 740pp.
2. De Abreu FVS, Morais MM, Riberio SP, Eiras AE. Influence of breeding site availability on the oviposition behavior of *Aedes aegypti*. Mem Inst Oswaldo Cruz. 2015; 110(5):669-76.
3. Lima Camera TN, Lima JB, Bruno RV, Peixoto AA. Effects of in –semination and blood-feeding on locomotor activity of *Aedes albopictus* and *Aedes aegypti* (Diptera: Culicidae) females under laboratory conditions. Parasit vectors, 2014; 7:304.
4. Lees RS, Knols B, Bellini R, Benedict MQ, Bheecarry A, Bossin HC, *et al.* Review: improving our knowledge of male mosquito biolo-gy in relation to genetic control programmes. Acta Trop, 2014; 132S:S2-S11.
5. Hales, S., Weinstein, P., and Woodward, A: 1996, 'Dengue fever Epidemics in the South Pacific: Driven by El Nino South Oscillation? ', Lancet 348, 1664-1665.
6. Nicholls N. 'El Nino-Southern Oscillation and Vector-Borne Disease', Lancet, 1993; 342:1284-1285.
7. Powell JR, Tabachnick WJ. History of domestication and spread of *Aedes aegypti* –a review. Memorias do Instituto Oswaldo Cruz, 2013; 108:11-17.
8. Diniz DFA, Albuquerque CMR, Oliva LO, Melo-Santos MAV, Ayres CFJ. Diapause and quiescence: Dormancy mechanisms that contribute to the geographical expansion of mosquitoes and their evolutionary success. Parasites & Vectors. 2017; 10:310.
9. Whitehead SS, Blaney JE, Durbin AP, Murphy BR. Prospects for a dengue virus vaccine. Nature Reviews Microbiology, 2007; 5:518.
10. Foster WA, Walker ED. Mosquitoes (Culicidae). In Mullen, G., Durden, L. (Eds.) Medical and veterinary Entomology (p 203-262). Academic press, San Diego, CA, 2002, 597pp.
11. Maricopa County Environmental Services. Lifecycle and information on *Aedes aegypti* mosquitoes. Maricopa County, AZ. <http://www.maricopa.gov/EnvSvc/VectorControl/Mosquitoes/MosqInfo.aspx> (13 may 2008), 2006.
12. Brett GA. On the relative attractiveness to *Aedes aegypti* of certain coloured cloths. Transactions of the Royal Society of Tropical Medicine and Hygiene. 1938; 32(1):113-124.
13. Christophers SR. *Aedes aegypti* (L.), the yellow fever mosquito. Its life history, bionomics and structure, London, Cambridge University Press, 1960.
14. Burkett-Cadena ND, Eubank MD, Unnasch TR. Preference of female mosquitoes for natural and artificial resting sites. Journal of the American Mosquito Control Association. 2008; 24(2):228.
15. Clements AN. The physiology of mosquitoes: Macmillan Company, New York, 1963.
16. Edman JD, Evans FDS, Williams JA. Development of a diurnal resting box to collect *Culiseta melanura* (COQ.). The American Journal of Tropical Medicine and Hygiene. 1968; 17(3):451-456.

17. Edman J, Kittayapong P, Linthicum K, Scott T. Attractant resting boxes for rapid collection and surveillance of *Aedes aegypti* (L.) inside houses. *Journal of the American Mosquito Control Association*. 1997; 13(1):24.
18. Gdtzevich AV. The reproduction and development of the yellow fever mosquito under experimental conditions. *Mag. Parasit. Lenigr*, 2:35 (in Russian; German summary p. 53. Summarized in *Rev. Appl. Ent*, 1931; 21:22.
19. Githeko AK. Advances in developing a climate based Dengue outbreak models in Dhaka, Bangladesh: challenges and opportunities. *Indian J Med Res*, 2012; 136:7-9.
20. Goodwin MH. Studies on artificial resting places of *Anopheles quadrimaculatus* say. *The Journal of the National Malaria Society*, 1942; 1:93.
21. Gubler D. Dengue and hemorrhagic fever. *Clinical Microbiology Reviews*, 1998; 11:480-496.
22. Gubler DJ. Dengue and West Nile virus—an interview with Duane Gubler, Sc.D., reported by Vicki Glaser. *Vector Borne Zoonotic Dis*, 2001; 1:81-88.
23. Gubler DJ. The economic burden of Dengue. *Am J Trop Med Hyg*, 2001; 86:743-744.
24. Guha-Sapir D, Schimmer B. Dengue fever: new paradigms for a changing epidemiology. *Emerging Themes in Epidemiology*, 2005; 2:1-10.
25. Guzman MG, Kouri G. Dengue: an update. *Lancet Infectious Diseases*, 2002; 2:33-42.
26. Halstead SB. Dengue. *Lancet*, 2007; 370:1644-1652.
27. Harbison JE, Mathenge EM, Misiani GO, Mukabana WR, Day JF, *et al*. A simple method for sampling indoor-resting malaria mosquitoes *Anopheles gambiae* and *Anopheles funestus* (Diptera: Culicidae) in Africa. *Journal of Medical Entomology*. 2006; 43(3):473-479.
28. Howard JJ, White DJ, Muller SL. Mark-recapture studies on the *Culiseta* (Diptera: Culicidae) vectors of eastern equine encephalitis virus. *Journal of Medical Entomology*. 1989; 26(3):190-199.
29. Kay BH. Collection of resting adult mosquitoes at Kowanyama, Northern Queensland and Charleville, South Western Queensland. *Australian Journal of Entomology*. 1983; 22(1):19-24.
30. Kittayapong P, Linthicum KJ, Edman JD, Scott TW. Further evaluation of indoor resting boxes for *Aedes aegypti* surveillance. *Dengue Bulletin*, 1997; 21:77-83.
31. Kweka EJ, Mwang'onde BJ, Kimaro E, Msangi S, Massenga CP, Mahande AM, *et al*. A resting box for outdoor sampling of adult *Anopheles arabiensis* in rice irrigation schemes of lower Moshi, northern Tanzania. *Malaria Journal*. 2009; 8(1):82.
32. Liebman KA, Stoddard ST, Reiner Jr RC, Perkins TA, Astete H, Sihuinchu M, *et al*. Determinants of heterogeneous blood feeding patterns by *Aedes aegypti* in Iquitos, 2014.
33. Marcantonio M, Metz M, Baldacchino F, Arnoldi D, Montarsi F, Capelli G, *et al*. First assessment of potential distribution and dispersal capacity of the emerging invasive mosquito *Aedes koreicus* in Northeast Italy. *Paras. Vec*, 2016; 9:2-19.
34. Montarsi F, Drago A, Martini S, Calzolari M, Filippo FD, Bianchi A, *et al*. Current distribution of the invasive mosquito species, *Aedes koreicus* (*Hulecoeteomyia koreica*) in northern Italy. *Para. Vec*, 2015; 8:1-5.
35. Morris CD. A structural and operational analysis of diurnal resting shelters for mosquitoes (Diptera: Culicidae). *Journal of Medical Entomology*. 1981; 18(5):419-424.
36. Muir LE, Kay BH and Thorne MJ. *Aedes aegypti* (Diptera: Culicidae) vision: response to stimuli from the optical environment. *Journal of Medical Entomology*. 1992; 29(3):4.
37. Nasci RS, Berry RL, Restifo RA, Parsons MA, Smith GC, Martin DA. Eastern *Equine encephalitis* virus in Ohio during 1991. *Journal of Medical Entomology*. 1993; 30(1):217-222.
38. Oliver J, Howard JJ, Morris CD. Fecundity of naturally blood fed *Culiseta melanura*. *Journal of the American Mosquito Control Association*. 1996; 12(4):664-668.
39. Ounibos LP, Escher RL, Lourenco-de-Oliveira R. Asymmetric evolution of photoperiodic diapause in temperate and tropical invasive populations of *Aedes albopictus* (Diptera: Culicidae). *Annals of the Entomological Society of America*, 2003; 96:512-518.
40. Patz JA, Epstein PR, Burke TA, Balbus JM. Global climate change and emerging infectious diseases. *JAMA*, 1996; 275:217-223.
41. Pinto E, Coelho M, Oliver L, Massad E. The influence of climate variables on Dengue in Singapore. *Int J Environ Health Res*, 2011; 21:415-426.
42. Seaton DR, Lumsden WHR. Observations on the effects of age, fertilization and light on biting by *Aedes aegypti* (L.) in a controlled microclimate. *Ann. Trop. Med. Para-it*, 1941; 35:23-36.
43. Sippell WL, Brown AWA. Studies of the responses of the female *Aedes* mosquito, Part V. The role of radiant energy. *Journal of Economic Entomology*. 1953; 30(2):309-312.
44. Weathersbee AA, Meisch MV. An economical lightweight portable resting unit for sampling adult *Anopheles quadrimaculatus* populations. *Journal of the American Mosquito Control Association*. 1988; 4(1):89-90.
45. Yasuno M, Rajagopalan PK, Russel S. An application of the removal method to the population estimation of *Culex fatigans* resting indoors. *The Indian Journal of Medical Research*, 1976; 65:34-52.