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A globally preferred dengue vector *Aedes albopictus*: An overview and identified in urban area of Udaipur, Rajasthan (India)

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Abstract
The primary vector of Dengue and a possible vector of Chikungunya is *Aedes albopictus*. Additionally, several arboviruses, including dog heartworm, Ross River virus, yellow fever, Cache Valley and West Nile virus, St. Louis, La Crosse, Japanese, eastern, western, and Venezuelan encephalitis, as well as Dirofilaria repens avian malaria, could be transmitted by this species of mosquito. An overview of the bio-ecology, medicine, and veterinary significance of *Aedes albopictus* is attempted in this article. It operates as a significant "urban, peri-urban and rural bridge vector" which crosses different reservoir/amplifier hosts to humans because of its experience with different vertebrates.
Because of its invasive habit, ecological adaptability, host specificity, high reproductive potential, and genetically increased repertoire of immune genes, *Aedes albopictus* has become a highly effective vector. This review details the identification and characterisation of *Aedes albopictus*, the principal Dengue vector, in comparison to *Aedes aegypti*. The Dengue Virus is the source of dengue fever, an illness spread by mosquitoes. *Aedes albopictus* is thought to have a role in the transmission of dengue, as reported in recent investigations. Severe dengue, commonly known as dengue hemorrhagic fever, occurs in a tiny percentage of cases. The adult heads of each species have distinct patterns of spots based on their shape. It is important to distinguish *Aedes albopictus* from *Aedes aegypti* due to the notable differences in the larval distribution and structure. *Aedes albopictus* identification is essential for monitoring the species, which is critical for controlling dengue vectors.

Keywords: *Aedes albopictus*, dengue

Introduction
An important class of arthropods that live in aquatic environments are mosquitoes. Most likely, these are harmful arthropods that spread a variety of infections and illnesses. There are currently 3549 recognized species of mosquitoes in the subfamily Culicinae that are reported worldwide, with over 100 species of mosquitoes that can transmit diseases to humans and other animals. The Genus Aedes makes up one-third of this subfamily, with members of *Ae. aegypti* and *Ae. albopictus* serving as the two main mosquito vectors for the dengue virus in Asia. The ecology of the *Aedes* mosquito was greatly altered by urbanization due to certain environmental changes. The mosquito species *aegypti* is the primary carrier of mosquito-borne diseases like Dengue, Zika, and yellow fever; hence vector management is important to prevent the spread of these severe viral infections. According to studies, 390 million individuals worldwide contract dengue each year, with 96 million cases of the infection being clinically confirmed (Bhatt *et al*., 2003). Additionally, international travel and global freight transit play a crucial role in the rapid spread of diseases carried by mosquitoes. In tropical and subtropical region, *Ae. albopictus* are active all year round. They deposit their eggs on the surfaces of water-filled objects throughout the winter, including tires, flowerpots, bird baths, and animal watering dishes. Eliminating these mosquitoes hatching grounds is a successful strategy for controlling mosquito vectors.
Aedes alhopicius was thought to only live on a few islands in the Indian Ocean, a few nations in eastern Asia, and the Hawaiian Islands in the Pacific Ocean up until the early 1980s (Huang, 1972) [19]. In many tropical and sub-tropical areas of the world, dengue became a serious public health concern in the second half of the 20th century. Right now, it is the most significant virus that infects humans and is spread by mosquitoes, both in terms of cases and fatalities. The World Health Organization is of the opinion that dengue poses a serious worldwide hazard (WHO). The first epidemic in India to be confirmed by virology was in 1956 in Vellore, Tamil Nadu (Rao, 1987) [33].
The first significant dengue outbreak started in 1963 in West Bengal's Calcutta and later expanded to neighboring states, impacting the majority of the nation (WHO). This was the first dengue outbreak in India that resulted in 200 deaths and a sizable number of DHF cases, with up to 30% of individuals exhibiting hemorrhagic symptoms. (Hati *et al*., 2006; Lall, R. *et al*., 1996; Rao, 1987) [16, 23, 33]. Dengue virus DENV show wide range of symptoms varying from mild to classic fever. Many symptoms such as dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS), are frequent and death causing; the main cause of death is typically massive plasma leakage leading to circulatory collapse (WHO, NAVBDCP 2007). There is no specific treatment for DHF or DSS although with proper clinical diagnosis and management fatality rates are less than 1% (Central Bureau of Health Intelligence. Public Health Statistics 2003) [8].

Dengue: An Over View
Many people, particularly young children and teenagers, may have a mild form of dengue fever with no symptoms at all. When symptoms do appear, they typically start four to seven days after the insect bite. A high fever of up to 104°F, headache, joint, muscle, and nausea, vomiting, pain behind the eyes, swollen glands, and rashes are all symptoms of dengue fever.

Global Burden of Dengue

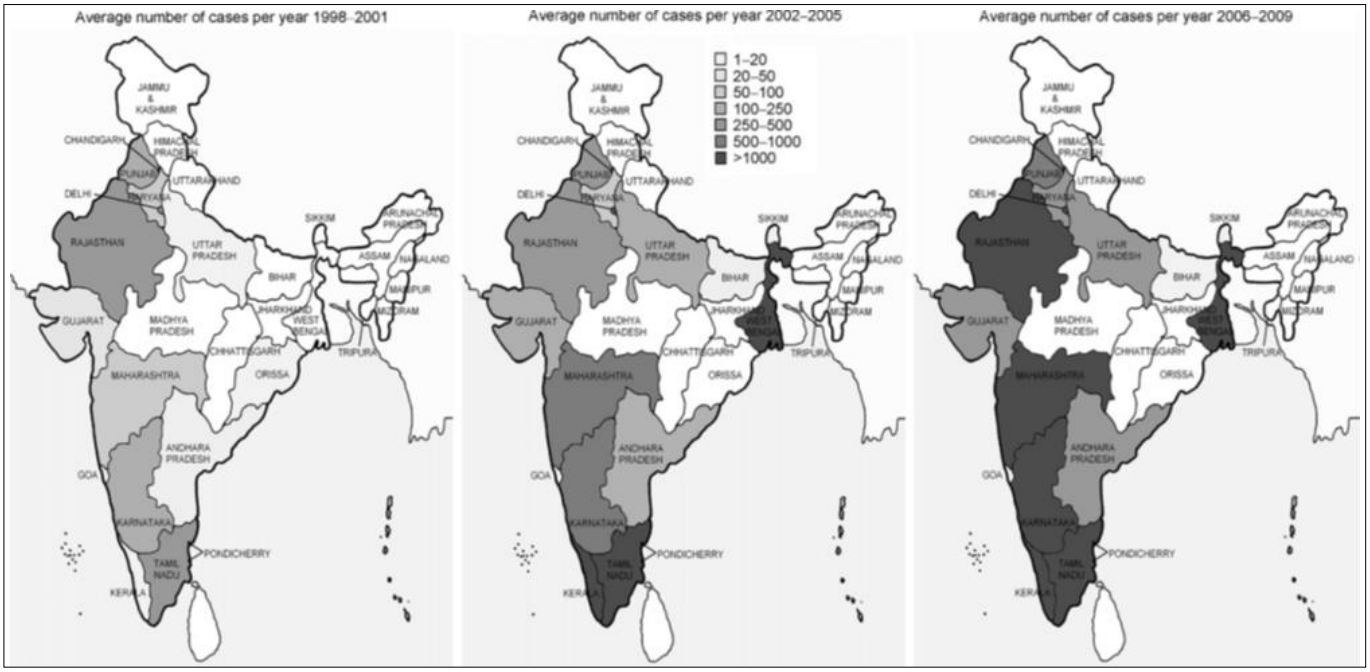


Fig 1: Average annual number of dengue cases in the states and Union Territories of India for 1998–2001, 2002–2005 and 2006–2009. Compiled from data published by National Vector Borne Disease Control Program (NVBDCP).

Over 40% of the world's population, or over 2.5 billion people, are currently at risk of contracting dengue. According to WHO estimates, there may be over 100 million dengue illnesses year worldwide. Every year, an estimated 500,000 persons with severe dengue need to be hospitalized; a significant number of these patients are youngsters. 2.5% or so of those impacted pass away. The world's most rapidly spreading virus spread by mosquitoes is dengue. The incidence has increased 30-fold over the last 50 years as a result of geographic expansion into new nations and, in the current decade, from urban to rural settings. There were just nine countries where significant dengue epidemics had occurred prior to 1970. Currently, over 100 nations in Africa, the Americas, the Eastern Mediterranean, South-East Asia, and the Western Pacific have an endemic case of the illness. With almost 2.3 million cases recorded in 2010, the regions most severely impacted are the Americas, South-East Asia, and Western Pacific. Together with the rise in incidence, the disease is also causing increasingly significant outbreaks to happen.

Transmission

The main mosquito that spreads dengue is Aedes aegypti. Humans contract the virus from female infected mosquitoes that bite them. A mosquito that has contracted the virus might spread it for the remainder of its life after incubating it for four to ten days. The majority of viral carriers and multipliers are infected people, who also act as a source of infection for mosquitoes that are not affected. Once symptoms start to show, patients who have already contracted the dengue virus can spread the infection through Aedes mosquitoes for a maximum of 12 days (4–5 days). The *Ae. aegypti* mosquito breeds primarily in artificial containers and inhabits urban environments. This species feeds during the day; the best times to see it bite are early in the morning and right before twilight. Every feeding cycle, female *Ae. aegypti* bites several persons. The international traffic in used tires, which serve as a breeding environment for *Aedes albopictus*, timber, and other items like "lucky bamboo," a decorative house plant that is sold all over the world, has played a major role in the spread of this secondary dengue vector from Asia to North America and Europe. This type of mosquito may thrive in Europe's milder temperate zones.

Ae. albopictus is incredibly durable, has a broad geographic distribution, and can live in both urban and rural settings. The extraordinarily resilient eggs of the mosquito can survive the entire dry season. It is a midday feeder as well. Travelers are crucial to the dengue outbreak because they can introduce new strains of the virus into regions where mosquitoes can spread the disease. Travelers who become infected can serve as early warning systems for outbreaks, especially if they have access to cutting-edge research facilities that can yield comprehensive details about a virus, like serotype and sequencing. There are no antiviral drugs that effectively treat dengue infection. In cases of severe dengue, it is critical to maintain the patient's body fluid volume. No commercial vaccine against dengue is available yet, although several candidate vaccines are currently in various phases of trials.

Global Distribution of Dengue Vector *Aedes albopictus*

Originally from Southeast Asia, *Aedes albopictus* is now found across the Oriental area, ranging from the islands in the Pacific and Indian Oceans, through China and Japan, north to Madagascar, and throughout the tropics of Southeast Asia (Novak, 1992) [32]. Additionally, it was brought to and later established throughout Europe, Africa, North and South America, and Asia (Novak, 1992) [32].

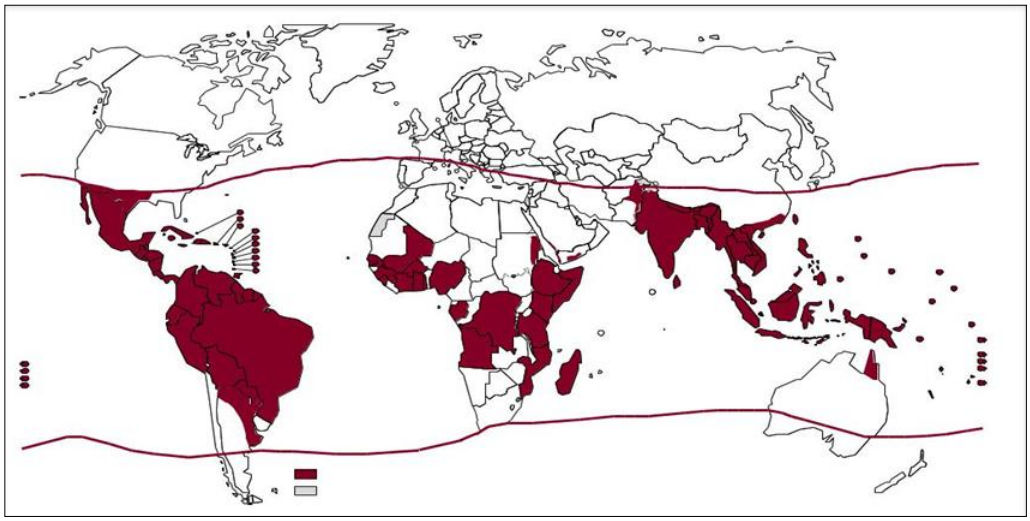


Fig 2: General Areas where species are recorded

Life Cycle of *Aedes* Mosquite

For proper development Mosquito larvae and pupae require an aquatic habitat with flowing or standing water. Most of the mosquito species larvae filter and feed on organic materials and other microbes which are present in water. For the larvae, microorganisms from detritus surfaces or containers, such as bacteria, fungus, and protozoans, are important. A great supply of mosquito larval habitats are freshwater swamps, rice fields, borrow pits, marshes, puddles, water-filled paths, ditches, galleys, and drains. Natural habitat for mosquito is rock pools, water filled bamboo stumps, tree holes, leaf of banana, snail shell, coconut shells and any emply container filled with water.

Mosquito breeds at man made container habitats such as cooking utensils filles with water or tins cans, car tires etcs. The larvae become pupae when they complete their fourth molting stage. Pupae lives for one to three days prior to change into adults and stop feeding. Female mosquitoes feeds on blood meal to produce viable eggs while male mosquitoes feed on plant nectar to obtain sugar. In ambient conditions, female mosquitoes mates every three to five days. *A. albopictus* females are diurnal feeders; they not only feed on large mammals but also imbibe blood meals from birds.

Identification of *Aedes* Mosquito

Morphological identification is an old traditional method for mosquito species identification that depends on exterior features of the species. Taxonomic keys are frequently used such as Bram, Harrison and Scanlon, Rattanarithikul, for the morphological identification of certain mosquito species. Morphological identification requires a great deal of effort and expertise, and it can lead to inaccurate identification when important morphological traits like scales and bristles are compromised. There are number of molecular biology techniques that are used for quick identification of species.

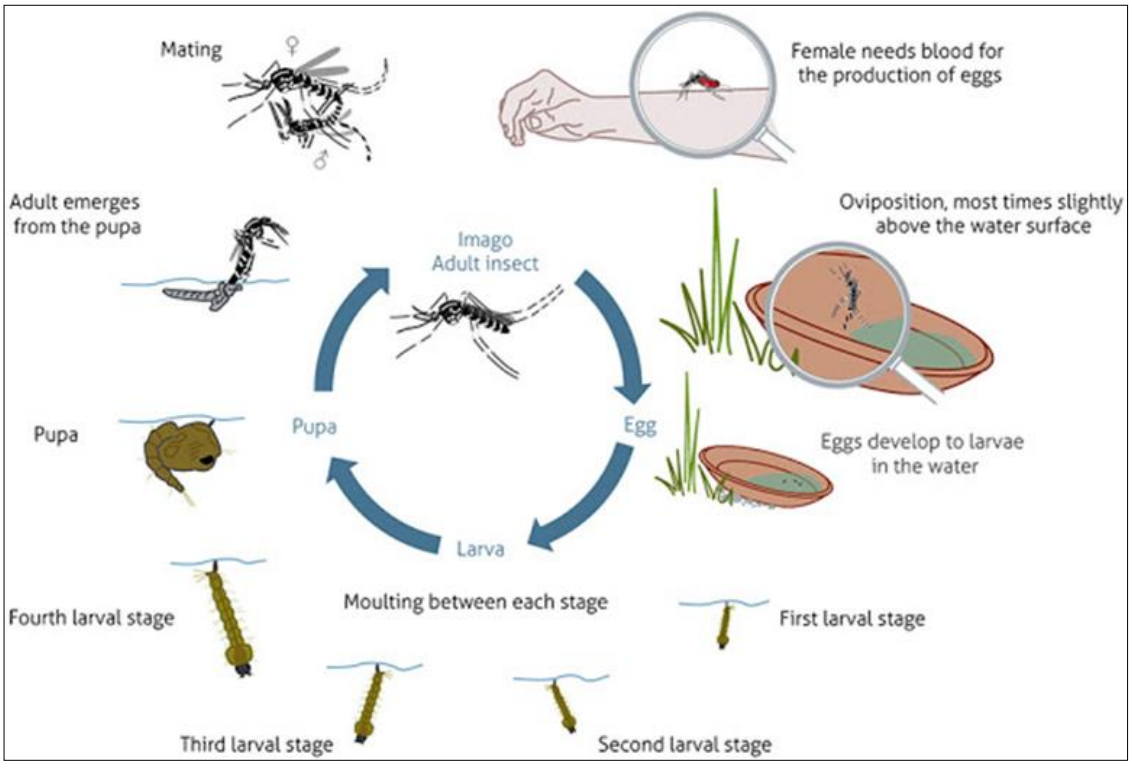
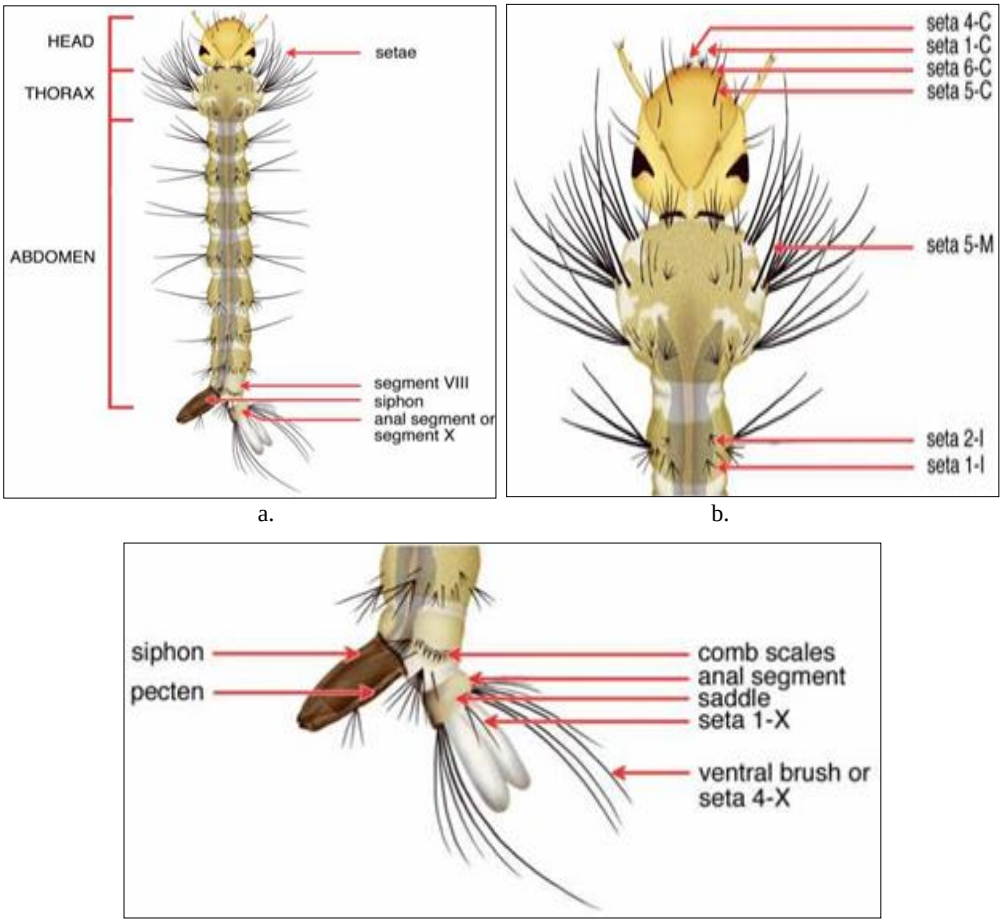


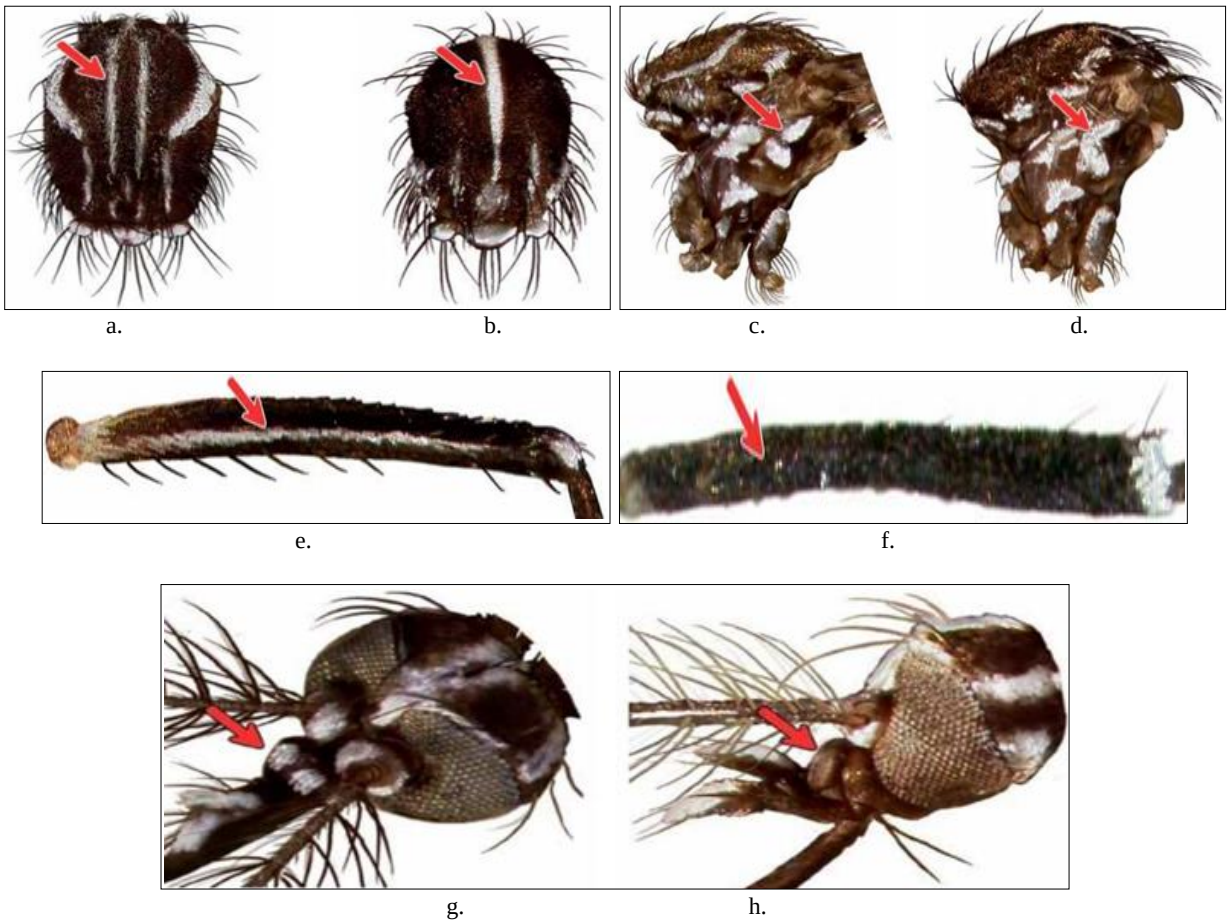
Fig 3: Showing life cycle of *Aedes*



a. b.

c.

Fig 4: (a) Dorsal view of mosquito larva (segments VIII and X, lateral view) - *Aedes (Stegomyia) albopictus*. (b) Dorsal view of larval head, thorax and abdomen (part) - *Aedes (Stegomyia) albopictus*. (c) Lateral view of larval abdomen (part) - *Aedes (Stegomyia) albopictus*.



a. b. c. d.

e. f.

g. h.

i. j.

Fig 5: (a) *Aedes (Stegomyia) aegypty* (b) *Aedes* (Stegomyia) *albopictus*. (c) *Aedes* (Stegomyia) *aegypty* (d) *Aedes* (Stegomyia) *albopictus* (e) *Aedes* (Stegomyia) *aegypti*. (f) *Aedes* (Stegomyia) *albopictus* (g) *Aedes* (Stegomyia) *aegypti* (h) *Aedes* (Stegomyia) *albopictus* (i) *Aedes* (Stegomyia) *aegypti*- Adult (j) *Aedes* (Stegomyia) *albopictus*- Adult

***Aedes albopictus* (Skuse)**

Aedes albopictus has a long history of breeding containers all over the world. It can reproduce in both natural and man-made settings. It is primarily a forest-edge mosquito that breeds in organic sites like leaf axils, cut bamboo stumps, tree holes, and rock crevices. The fast expansion of plantations, especially those growing rubber, cocoa, and areca nut crops, and extensive deforestation contributed to the tiger mosquito's rapid spread. Extensive breeding in containers used to collect rubber sap during the rainy season has been seen in rubber farms (Sumodan, 2008) [38]. In the Malabar region's Western Ghat, extensive breeding has produced shed areca nut palm leaf sheaths and cocoa pods that hang from the trees and are grounded (Regu *et al*., 2008; Hiriyan and Tyagi, 2004) [35, 18].

According to reports, *Ae. albopictus* primarily breeds in household waste such as coconut shells and plastics, with additional breeding sites found in rural Calicut, Kerala, where flower pots, glass items, and tires are said to be present (Bhaskar, 2010) [5]. Pineapple plants encourage maximal breeding of *Ae. albopictus*, and Kerala has significant pineapple farms (Eapen *et al*., 2010) [13]. In comparison to *Aedes aegypti*, *Aedes albopictus* was more reliant on rainfall, with its larval density dramatically increasing following monsoon rains that filled up all of the peridomestic containers scattered around that area (Almeida *et al*., 2005) [1].

Prior to the monsoon, *Ae. albopictus* was mostly found in artificial containers from peri-domestic habitats. Over the past forty years, the rate of urban expansion has increased from 18% to 27%. This has resulted in the degradation of natural habitats, forcing *Ae. albopictus* to adapt to reproducing in artificial containers instead of natural settings, as shown in China (Jian-fen *et al*., 2007) [20]. In Kerala, *Aedes albopictus* was a key factor in the spread of dengue, and in several locations, its density was 93.2 percent. Dengue and chikungunya virus were transmitted through *Ae. albopictus* in Kerala (Tyagi *et al*., 2006a, Tyagi and Dash, 2006b, Thenmozhi V *et al*., 2007, Niyas *et al*., 2010, Tyagi *et al*., 2003) [45, 46, 40, 31, 44]. As compared to *Aedes aegypti*, *Aedes albopictus* is more likely to live and feed outside and it consumes blood meal from both humans and animals easily (Almeida *et al*., 2005, Pant *et al*.,1973) [1, 34]. With increasing tire trafficking, *Ae. albopictus* has started living outside its natural habitat in at least 28 more nations. This increased its aggressive human-biting behavior during day. (Benedict *et al*., 2007) [3]. Due to this has the ability to transmit a variety of viruses (Delatte, *et al*., 2009) [11].

The true suspicion was confirmed in 2004 when the dengue virus was found in *Aedes albopictus* specimens collected near Calicut Airport in Kerala (Das *et al*., 2004) [10]. *Ae. albopictus* has been known to bite in Brazil during the day, peaking between 4:00 and 5:00 pm, 1:00–2:00 pm, and 6:00 a.m. (Marques and Gomes 1997) [29]. *Ae. albopictus* was observed to exhibit exophagic (89%) and exophilic (87%) behaviors in a study carried out on Reunion Island (Delatte *et al*., 2010) [12]. Biting activity peaked between 22:30 and 23:00 hours, then between 20:30 and 21:00 hours, and between 20:00 and 20:30 hours, no biting was seen (Sumodan, 2014) [39].

The largest (15.7%) mosquito infection in the Jodhpur area of Rajasthan, India, was found to be *Ae. albopictus*, followed by *Ae. aegypti* (12.6%) and *Ae. vittatus* (5.14%), according to pooled data for all four seasons. The seasonal split of observations shows that the trend is the similar in the summer and winter, however in the rainy season, *Ae. albopictus* (12.2%) and *Ae. aegypti* (maximum vertically infected mosquitoes) were the most prevalent (Bennet and Joshi, 2008) [2]. Data compiled for all four seasons in the Jaipur district of Rajasthan, India, revealed that *Ae. vittatus* had the highest (20%) infection rate of vertically transmitted viruses, followed by *Ae. albopictus* (18.7%) and *Ae. aegypti* (13.3%).

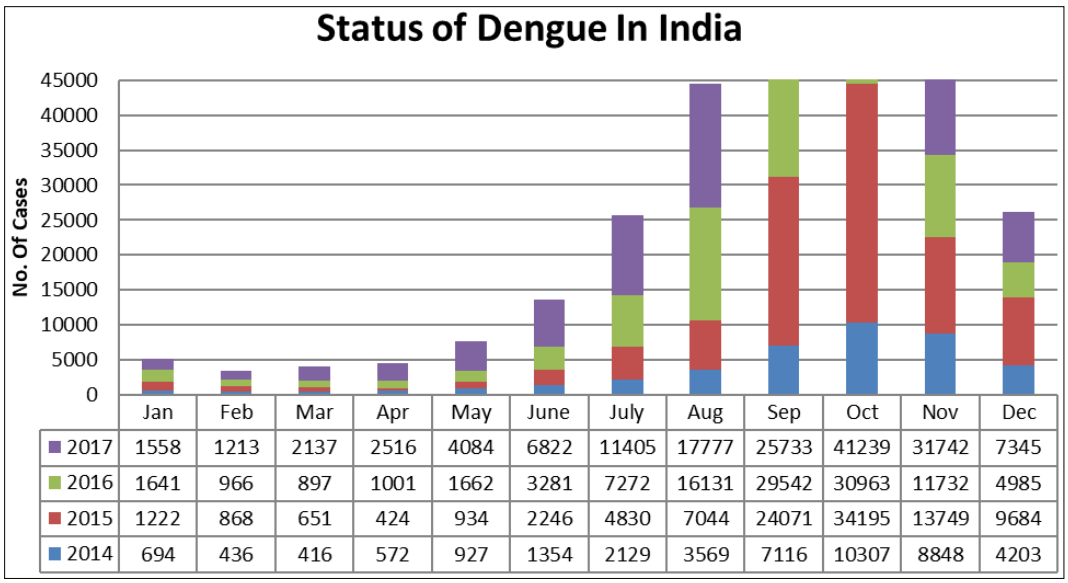
Aedes vittatus was the most common mosquito species to infect people during the rainy season (20.4%), with Aedes albopictus coming in second (18.7%) in separate seasons (Bennet and Joshi, 2008) [2]. However, only *Ae. aegypti* displayed vertically transmitted virus during the summer and winter. Pooled data for all four seasons in the Kota district of Rajasthan, India, revealed that *Ae. albopictus* mosquitoes had the highest vertical infection rate (14.2%), followed by *Ae. aegypti* (7.07%) and *Ae. vittatus* (4.76%) (Bennet and Joshi, 2008) [2]. *Ae. albopictus* has demonstrated the most proportion of vertically transmitted virus during the winter, which is not the dengue season in Rajasthan, India (Bennet and Joshi, 2008) [2].

Vectorial Capacity of *Aedes albopictus*-

Aedes albopictus, is a dangerous exotic vector for many contagious diseases. It is a vector of dengue (Mitchell *et al*.,1987; Hawley., 1988) [27, 17], Japanese encephalistis

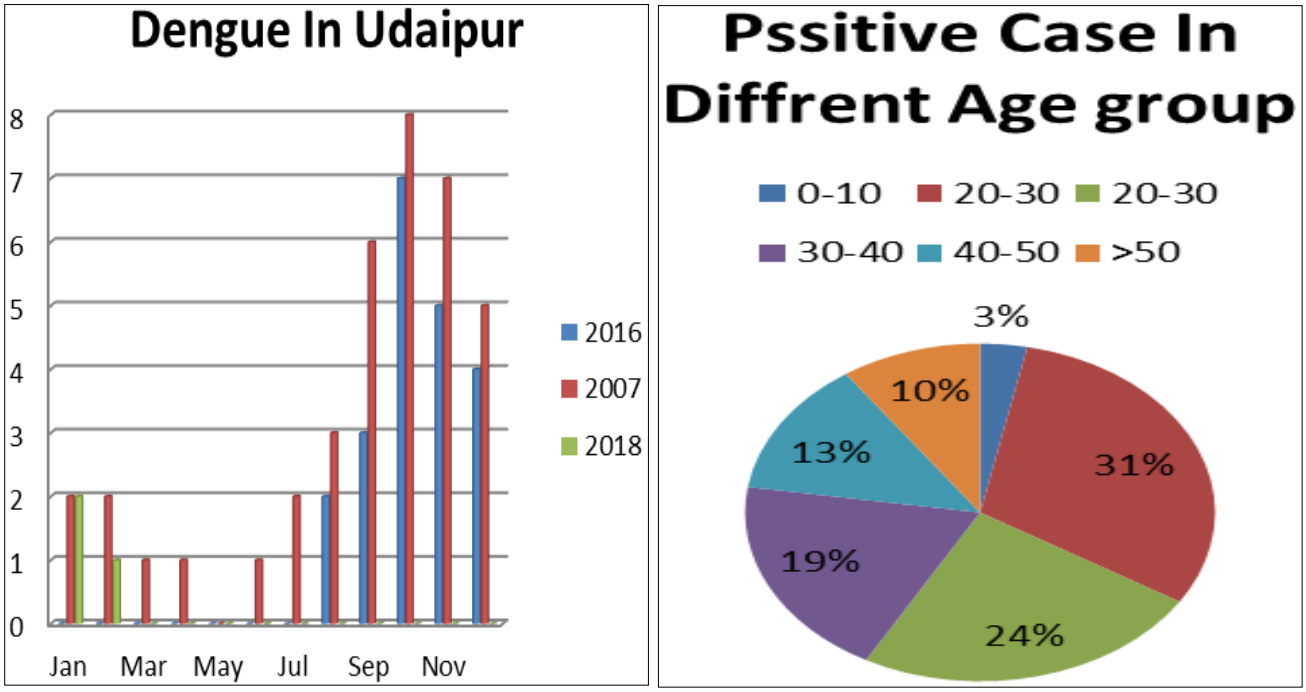
(Weng., *et al* 1997;1999) [47], Western enquine encephalitis (Fernandez *et al*., 1992; Turell *et al* 1994) [43], Venezulean enquine encephalitis (Fernandez *et al*., 2003), River ray disease (Kay *et al*.,1982; Lee *et al*., 1984) [22, 25], Eastern enquine encephalitis, Cache valley (Mitchell *et al*.,1998) [26], West Nile Virus (Tiawsirisup *et al*., 2005) [42], Yellow fever (Mitchell *et al*., 1987; Johnson *et al*., 2002) [27, 21], St. Louis encephalitis (Savage *et al*., 1994) [37], La crosse encephalitis (Gerhartdt *et al*., 2001) [15] and chikunguniya virus (Tesh *et al*., 1976; Reiter *et al*., 2006) [41, 36]. *Aedes albopictus* is a well knoen vector of dog heartworm *Dirofilaria immitis* (Chellappah and Chellappah 1968; Lee *et al*., 2003a). It also transmits *Dirofilaria repens* (Cabcrini *et al*., 2003b). *Aedes albopictus* is known to transmit avian malaria also in some species of birds (La pointe *et al*., 2005) [24].

Statistical Position of vector in India with Special reference to Udaipur



	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2017	1558	1213	2137	2516	4084	6822	11405	17777	25733	41239	31742	7345
2016	1641	966	897	1001	1662	3281	7272	16131	29542	30963	11732	4985
2015	1222	868	651	424	934	2246	4830	7044	24071	34195	13749	9684
2014	694	436	416	572	927	1354	2129	3569	7116	10307	8848	4203

Fig 6



Data collected from the Journal of Community Health Management, January-March 2018; 5(1):10-12)

Fig 7

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