Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 5, No. 1, p. 97-104, 2014
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Morphological study of adult female *Aedes species* from the Amravati District of Maharashtra and its role as a vector

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Article published on July 08, 2014

Key words: *Aedes aegypti, A. alobopictus,* vector, Amravati.

Abstract

Amravati is a major district from Vidarbha region of Maharashtra. This tropical region shows extreme cold and extreme high temperatures during winter and summer seasons. The temperature reaches beyond a level of 45°C with lot of humidity during summer season. This climate favors to flourish mosquitoes breeding and in turn invites various mosquito borne diseases. Mosquito plays an important role in transmission of various diseases. Mosquitoes transmit diseases like Malaria, Filaria, Dengue Chikungunya (CHIK), Japanese Encephalitis and many more leading towards huge economic loss throughout the world. As Vidarbha is basically a tropical region where temperature. National Vector borne Disease Control Programme is based on the pioneer step of identification of mosquitoes to control mosquito borne diseases. Entomological surveillance for dengue fever (DF) and dengue hemorrhagic fever (DHF) is used to evaluate control programmes. Presence of *Aedes (Ae.) aegypti* spells the risk of DF/CHIK outbreaks in the area, its population prevalence is of importance for long-term vector control and disease prevention. *Aedes* can be easily identified due to white and black bands on the body as well as legs, but the species involved in transmission of different *Aedes* borne diseases need proper identification. A total of 111 species of *Aedes* were recorded In India. Two major species of *Aedes* recorded in the area are *Aedes aegypti* and *Ae. albopictus* as vectors.

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Introduction

Dengue and chikungunya are prime mosquito-borne viral diseases of great public health concern in India along with malaria and filaria. These are caused by Dengue virus (DENV) Serotypes DEN1-4 belonging to the Flaviviridae family and chikungunya virus (CHIKV) belonging to the togaviridae respectively. *Aedes* species viz *Aedes aegypti, Ae alobopictus* are the major vectors to transmit these viruses. *Aedes aegypti* (Linn. Diptera: Culicidae), serves as the most important domestic vector to transmit yellow fever and dengue in urban area (Gubler, 1988; Warren and Mahmoud, 1990) *Ae. aegypti* breeding site preferences have been studied in many areas with varying results. Discarded automobile tires were found to be an ideal site in the USA (Tinker, 1964; Chambers *et al.,* 1986) and in Puerto Rico (Moore *et al.,* 1978), whereas large drums were preferred in Colombia (Nelson *et al.,* 1984). In a brief overview of typical breeding sites around the world, *Ae. aegypti* can able to utilize any small container to lay eggs. Excessive use of water cooler during summer season is the main breeding site of *Aedes species* (Bar *et al.,* 2012). The relationship between death and percentage of population infected varies substantially. Hayes and Gubler (1992) suggested that out of 100 dengue fever cases, 1 - 7 are of dengue hemorrhagic fever and 50% of all DHF cases would die due to mismanagement in treatment.

Dengue fever outbreaks are reported from India since last 10 years. Since 2005, chikungunya is also causing massive outbreaks in India and other parts of Asia (Kumar KJ, *et al.,* 2012). The incidence of dengue in Malaysia has been rising steadily, from 7,103 cases in 2000 to 46,171; including 134 deaths, in 2010 and the disease costs the Malaysian economy between RM270 million and RM667 million per annum. In light of this, the Malaysian government has identified dengue control as a national priority. Dengue has also put some 2.5 billion people in more than 100 countries at risk, 50-100 million people suffering from dengue annually, 7-16 thousand cases in India having case fatality rate 0.05-3.30. Dengue percentage in Southeast Asian countries is 24% i.e 1.7 billions. Dengue fever outbreaks are reported from India since last 10 years. Since 2005, chikungunya is also causing massive outbreaks in India and other parts of Asia. Chikungunya disappeared in 1973 and re-emerged after a gap of more than three decades in 2005, Since 2005, quite a few outbreaks have been reported from different parts of India.

Epidemic of Chikungunya is widespread throughout the world, mainly in Africa, the Indian subcontinent and Southeast Asia, particularly the Philippines, Thailand, Cambodia, Vietnam, Mauritius and Sri Lanka. It affects all age groups but more than 50% are over the age of 65 years - of which a third will die. The pain associated with CHIKV infection of the joints persists for weeks or months, or in some cases years,(Powers and Logue , 2007 & Sourisseau , *et al.,* 2007), depending on their age (Simon *et al.,*2007 & Taubitz , *et al.,*2007). Thiboutot MM, 2010 stated that there is severe illness also occurs in children suffering from Chikungunya. There was an exceptionally virulent outbreak in the French island of La Reunion in the Indian Ocean, in 2005 and 2006, which also affected neighbouring islands, including Mauritius. Renault P., *et al.,* 2007, Beesoon S., *et al.,* 2008). In Delhi, in the year 2010, several cases of fever of dengue and chikungunya virus infection reported. The IgM seropositivity of chikungunya was found to be 65.11% and that of dengue as 37.86%(Balvinder Singh Arora, 2013). Large urban outbreaks of Chikungunya have been reported in Kolkata and Chennai in 1960. It was last seen in Barsi in Maharashtra where it involved as much as 37.5 per cent of the town (Padbidri, *et al.,* 1979). It has continued for decades, apparently at a low prevalence (Mourya, *et al.,* 2002). The epidemic which started in end-2005 affected - according to official estimates - more than 1.3 million people in more than 150 districts in eight states (Outbreak news: Chikungunya, India,2006).

Chikungunya virus is indigenous to tropical Africa and Asia, where it is transmitted to humans by the

bite of infected *Aedes* mosquitoes, but recent research by the Pasteur Institute in Paris has suggested that Chikungunya virus strains in the 2005-2006 Reunion Island outbreak incurred a mutation that facilitated transmission by *Aedes albopictus*, by a point mutation in one of the viral envelope genes (E1). (Martin, 2007). Enhanced transmission of chikungunya virus by *Aedes albopictus* could mean an increased risk for chikungunya outbreaks in other areas where this species is present. A recent epidemic in Italy was likely perpetuated by *Aedes albopictus*.

In Amravati district alone during 2003-04, there were 1455 reported patients of malaria out of which 5 died as per the Maharashtra Government record while 8 patients were found suffering from Japanese Encephalitis, 6 dengue patients and 14 of chikungunya and fatality rate observed in case of Japanese encephalitis was 38 %.

Large number of various mosquito borne diseases in the area has tempted to study the biodiversity of mosquitoes, their prevalence and habitats so that some control measures specific to this areas can be recommended. By going through such a devastating health problem of mosquito borne diseases, in the present study the identification of the mosquitoes responsible for these diseases become necessary as for the transmission of the diseases majorly *Ae. aegypti and Ae. albopictus are responsible.*
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Materials and methods

Sites for collection

Collection of adult mosquitoes from 5 different geographical regions of the district Amravati viz Morshi (21°12' and 21°34' N. 7748' and 7829' E.) Achalpur (21° 15' 26"N 77° 30'31"E 21.257222° N 77.50861°E.), Chandur Railway (20° 20' N and 74 °19' E), Daryapur (20.93° N, 77.33° E) and Amravati city(20.93° N and 77.75° E). Several specimens collected from different regions to be identified for biodiversity study.

Method used for collection

Several specimens collected from different regions that were resting indoor by net trap method or suction tube method during day time. The collections were made from human dwellings for diversity study.

Microscopic study

The morphology was studied with the help of Lyzer Zoom stereoscopic binocular microscope. Morphological identification of the specimens carried out by using characters like, bands on the body and legs, mouth parts like proboscis, maxillary palps, antennae wing venation, scales on wings and legs.

Results

The species identified are

Aedes aegypti (Linnnaeus) 1962

Aedes albopictus (Skuse) 1894.

Characteristic features of the species

Aedes (Stegomyia) aegypti (Linnaeus),1962

Female-Head

Silvery- white flat scales in middle of thorax, continued downwards between eyes, similar scales on tori, two small silvery white dots on clypeus, tips of palpi are conspicuously white. Proboscis is straight and dark. Antennae are very much reduced with 13 segmented structure having white scales.

Thorax

Dark, a lyre shaped mark on the scutum and longitudinal white line medially. Flat silvery-white scales on all lobes of scutellum.

Legs

Mid femur, when viewed from the front, with a white longitudinal line running from the base for nearly whole length, but not continued quite to knee. Anterior surface of hind femur pale on basal ½, or more, the pale scaling continued as a thin longitudinal near the knee. Tarsi of fore and mid legs with narrow basal white bands to first two or three

segments , those of hind legs with more conspicuous white basal rings on segment 1-4, that on 4 being usually the widest, segment 5 usually entirely white.

Wings

Wings dark with flat scales without white patches, posterior fringe scales are erect.

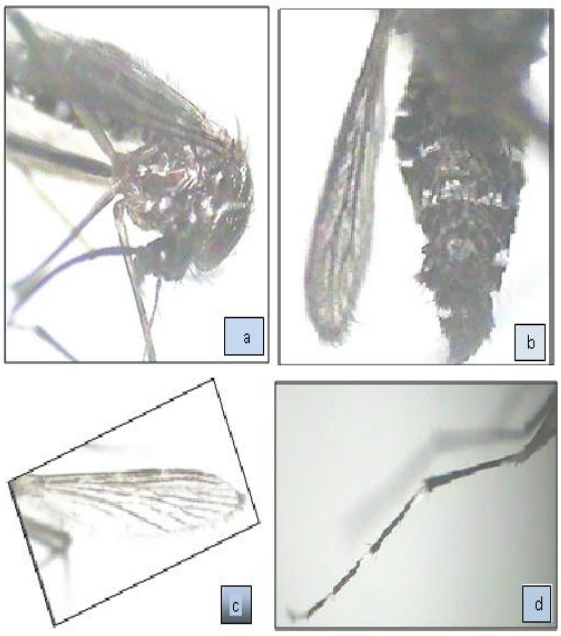

Fig. 1. Female *Aedes (Stegomyia) aegypti* (Linnaeus) 1962 a. Whole mount showing lyre mark on the head b. white basal bands on abdomen c. Wing with posterior fringe scales erect d. white bands on the leg segments.

Abdomen

Tergites brownish to black, with narrow dull white basal bands on II- VI, VII with two silvery white dots; VIII segment is very reduced, lateral silvery patches on I-VII not usually visible in dorsal view.

Male

Ornamentation similar to that of females. Palpi with two white rings on the long segment and with white marks on undersides of last two segments at base.

Aedes albopictus (Skuse)1894

Aedes albopictus—also called the Asian tiger mosquito approximately 0.5 centimeter long.

Female-Head

Rounded with dark colored proboscis maxillary palps are much shorter Distinct silver-white bands on the palpus.

Thorax

A line of flat silvery scales on border of mesonotum in front of wing root, a narrow silvery-white median line running nearly whole length of mesonotum.

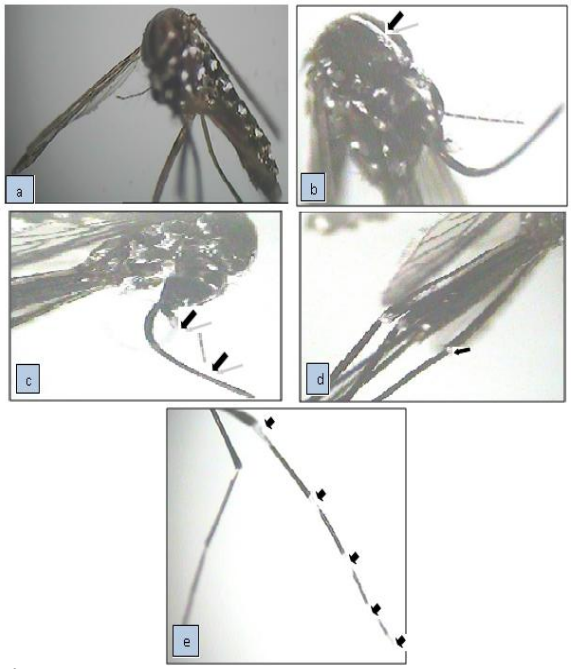

Fig. 2. Female *Aedes albopictus* (Skuse)1894 a. Whole mount b. Head showing A line of flat silvery scales on mesonotum c. Head showing white tip of short palpi and long dark proboscis d**.** femur black with white scales at the end e. tarsomeres with the ring of white scales.

Legs

The hind legs at the base of tarsomere I - IV and fore legs and middle legs, only I-III tarsomeres have the ring of white scales; tarsomere V of the hind legs is completely white. The femur black with white scales at the end except in the middle legs. Each leg ends into claws.

Wings

Transparent with dark venation and white patches at the basal portion of the costa, scales narrow.

Abdomen

With white triangular patches.

Male

very similar to females. Hypopygium shape of it characteristic, apical border produced in middle as a blunt point.

Discussion

The species observed during study are *Aedes aegypti* and *Ae. albopictus* showed white and dark striations all over the body. The head on the lateral side has kidney shaped compound eyes, palpi white. Proboscis is straight and dark. Antennae reduced.

The middle of the vertex has silvery white flat scales (Sathe and Girhe, 2002; Barraud PJ ,1934; Christophers SR., 1960; Huang YM.1979). Thorax of *Ae. aegypti* consists of the pro, meso and meta thoracic segments with legs and wings. Scutum is dark (Huang YM., 1979) and has brown scales (Rueda LM., 2004) with lyre shaped marking of white scales(Sathe and Girhe, 2002; Rueda LM., 2004, Christophers SR., 1960;Darsie RE Jr, Samanidou-voyadjoglou A.,1997; Ribeiro H, Ramos HC., 1999). Three lobed scutellum with silvery white scaly spots described by Christophers SR., 1960; Huang YM.1979). The leg has 5 segments from coxa to tarsus, white scale patches are present on coxae (Christopher SR, 1960). The tarsus ends into claws of unequal size except hindleg tarsi. Abdomen has 8 segmented structure. Barraud described that the dorsum of *A. annandalei* and *A. pipersalatus* were also black with white basal bands on segments II-VII. The II –VI segments had basal bands of white scales on the tergite (Sathe TV, Girhe BE., 2002; Barraud PJ ,1934; Huang YM., 1979). The morphological study of the various parts of adult show that the size of the different regions varied in male and female *Ae. aegypti.*

In the present study, *Aedes albopictus* is in accordance to the species described *by* Barraud PJ., 1934. Adult *Aedes albopictus* are easily recognized by the characteristic line of flat silvery scales on border of mesonotum in front of wing root. There are bold black shiny scales and distinct silver white scales on the palpi and tarsi (Hawley 1988). The abdomen is dark. Legs are black and white bands.

Dengue virus belongs to family Flaviviridae, having four serotypes that spread by the bite of infected *Aedes* species of mosquitoes. It causes a wide spectrum of illness from mild asymptomatic illness to severe fatal dengue haemorrhagic fever/dengue shock syndrome (DHF/DSS). Approximately 2.5 billion people live in dengue-risk regions with about 100 million new cases each year worldwide (Gupta *et al.,* 2012).

Dengue fever (DF), dengue haemorrhagic fever (DHF), and dengue shock syndrome (DSS) represent a spectrum of symptoms resulting from infection with the dengue virus transmitted by *Ae. aegypti* and *Ae. albopictus*. The first clinical case report dates from 1789 of 1780 epidemic in Philadelphia by Benjamin Rush

In India, the first epidemic of clinical dengue-like illness was recorded in Madras in 1780 and the first virologically proved epidemic of dengue fever (DF) occurred in Calcutta and Eastern Coast of India in 1963-1964 (Gupta *et al.,* 2012). The next major outbreak of Dengue/Dengue Haemorrhagic Fever was reported in Delhi and neighboring states in 1996.

Every year thousands of individuals are affected and contribute to the burden of health care Dengue outbreaks have continued since the 1950s but severity of disease has increased in the last two decades (Cecilia D., 2014).

In India, during the year 2007, 69 deaths out of 5534 cases(Case fatality rate (CFR) 1.3), in 2008 80 deaths out of 12561 cases (CFR 0.6), in 2009, 96 deaths out of 15535 cases (CFR 0.6), in 2010, 110 deaths out of 28292 cases (CFR 0.4), in 2011 7 deaths out of 1198 cases (CFR 0.6) recorded (Courtesy: data of National Vector Borne Disease Control Programme (NVBDCP)

In Maharashtra during the year 2007, 21 deaths out of 614 cases, in 2008 22 deaths out of 743 cases, in 2009, 20 deaths out of 2255 cases, in 2010, 5 deaths out of 1489 cases, in 2011 no death out of 46 cases recorded.(Courtesy: data of NVBDCP).

Chikungunya outbreaks started in the 1960s and its resurgence was in 2006. Based on the data of National Vector Borne Disease Control Programme (NVBDCP), the number of cases reported in 2013 was about 74 454 for dengue with 167 deaths and 18 639 for chikungunya. (Cecilia D., 2014).

S. Saini, *et al.,* 2013 tested total 917 blood samples, in which 281(30.6%) were positive for one or more of three markers. Of 281 blood samples NS1 was positive in 198 cases while NS1 with either IgM or IgG was positive in 16 cases. Only IgG in 25cases and only IgM in 28 cases was observed. All the three parameters were positive in 3 cases.

In 2013 National Vector Borne Disease Control Programme officials have counted more than 32,000 cases of dengue and 100 deaths in the country this year. Kerala has had the highest number of cases at nearly 7,000. The fatality rate is not as bad as it was last year, when 240 of 50,000 cases died across the country. *Aedes aegypti* transmit dengue and yellow fever only in areas where temperatures rarely fall below 10^{o} C. By going through these vast figures of Dengue and chikungunya leading devastating loss, the identification of *Aedes species* is a intimate need to control vector borne diseases.

Acknowledgement

Author is grateful to University Grants Commission, New Delhi for providing the grants through Major Project and Sant Gadge Baba Amravati University, Amravati to carry out the given work.

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