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Density and distribution of species *Culex quinquefasciatus* in the rural areas around Rajkot city, Gujarat, India

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Abstract
Intensive and extensive sample collection and field survey were conducted to study the density and seasonal distribution of *Culex quinquefasciatus* for the first time in the rural area around the Rajkot City. Species Identification, larval Density, Adult Density and Distribution of Breeding Sites of the species were studied in the seven villages around the Rajkot City area. Results show that density of adult *Culex quinquefasciatus* was recorded maximum in the month of September which was the pick month of monsoon in this region and lowest density found during the month of May which was pick summer in the study area. Furthermore, breeding sites of the *Culex quinquefasciatus* were also recorded more in the monsoon and post monsoon season. Therefore it was clearly indicate that the temperature, rainfall and humidity play major role in the density and distribution of *Culex quinquefasciatus*.

Keywords: *Culex quinquefasciatus*, density, breeding distribution, rajkot, rural

1. Introduction
Culex quinquefasciatus is a wide spread species throughout southeast and east Asia. It is also very common mosquito species found abundantly in the study area and prevalent throughout the year. Millions of people annually infected by the mosquitoes and also mosquitoes being vector of many diseases transmit infections like malaria, dengue, filarial, yellow fever, Japanese encephalitis and chikungunia etc. (Noutchamae and Anumudu CI., 2009) [9]. High micro filarial rates have been detailed in India in northern and coastal parts of Andhra Pradesh, Bihar, Tamil Nadu and Kerala and Coastal parts of Orissa and eastern parts of Uttar Pradesh and 2.5 million people are showing to the risk factors with about 2 million microfilaria carriers and 1.2 million disease cases occurs in India (Patel, 2002) [10].
There are fifty nine species of mosquito's vectors of the filarial among them most important vector is *Culex quinquefasciatus*. This species belongs to *Culex pipiens* complex, which is widely distributed in tropical and subtropical latitude. It is recorded up to over 1800 m. above this altitude it's not found because of weather conditions and lack of breeding places (Pemola and Jauhari, 2004) [11]. Augmented mosquito annoyance in most urban areas is mainly because of *Culex quinquefasciatus* (Batra *et al*., 1995) [2].
The major tropical vector-borne diseases are typically viewed as Associate in nursing environmental consequence of underdevelopment, occurring in communities (Brightmer and Fantato, 1998) [3]. Local dipteron distribution and flight vary depends upon breeding surround preference, availability of the host and resting preference. Biological invasions challenge our ability to grasp the organic phenomenon and abiotic method that governs distribution and abundance (Steven *et al*., 2004) [15].
Our study was aimed to find out the density, distribution and seasonal variation in population of selected areas in rural areas for *Culex quinquefasciatus* in different habitats for the first time. This work also describes mosquito's active habitats for breeding being significant for vector management and useful control strategies in selected areas of Rajkot rural.

2. Materials and Methods
The Study area situated near the Rajkot City (22°20'3"N 70°45'56"E), in the semi-arid tropical region of Gujarat where the clime was mostly hot and dry. Total seven villages around Rajkot city were selected for investigation on distribution and density of *Cx. quinquefasciatus* in outskirt and domestic shelters. All the selected seven villages are having network of canal irrigation drainage system (Figure 1). Due to seepages and water-logged from the canal create ideal habitat for the mosquitoes.

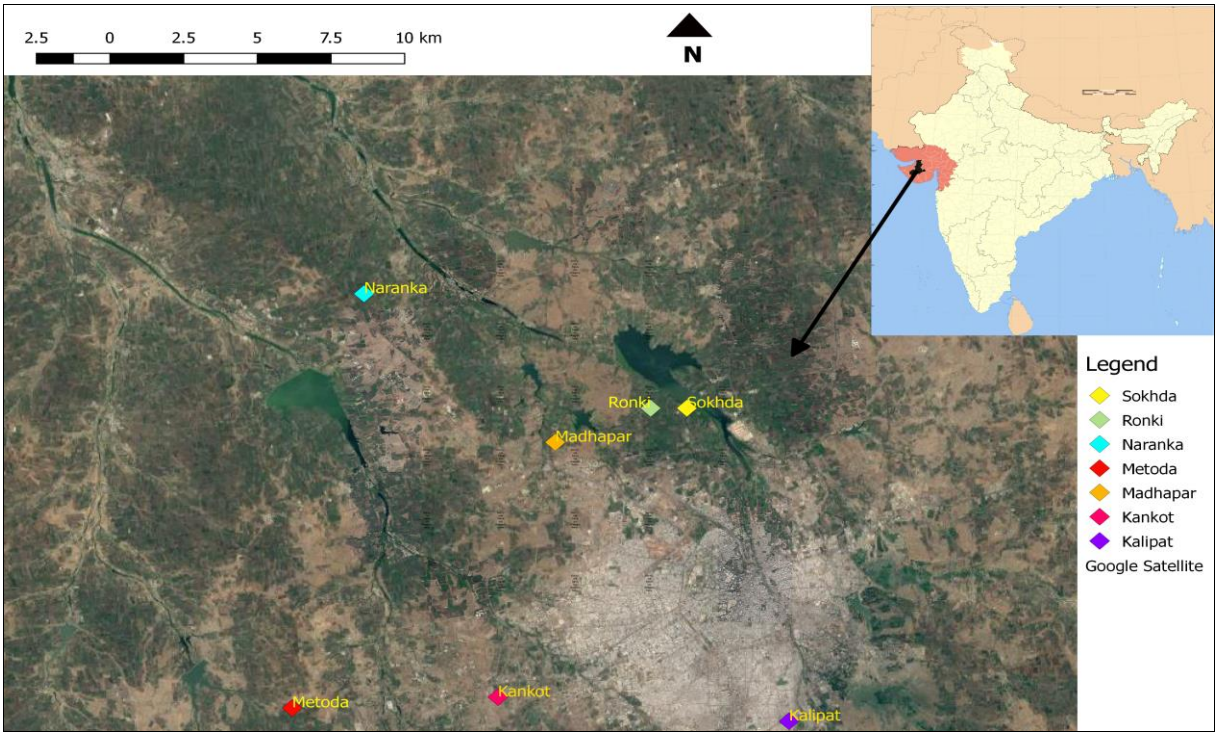

Fig 1: Showing study sites in the rural areas around Rajkot city (Source: Google Satellite image)

The villages are Madhapar, Naranka, Sokhda, Kalipat, Metoda, Ronki and Kankot were ideal for the assessment and have the semi-arid type climate with three distinct seasons, viz. summer (March to June), monsoon (July to September) and winter (October to February) months. The study area also having major two seasonal rivers Aji and Nyari and further having four major dams were building up for the irrigation purpose in the study area.

The study was conducted during 1st January 2006 to 31st December 2007. The dipping method was used as described by WHO (1975) [17, 18] for the Mosquitoes and larva collection from the residence area (domestic area) and surrounding of residence area (outskirt area) in the morning between 6 am to 8 am. References Key was used for the identification of mosquitoes and this larva (Roy and Brown, 1971; Patel, 2002; Sumit, 2008) [14, 10, 16]. Breeding sites and resting sites of the mosquito were categorized based on the observation during the sample collection of specimen. During the study period every month larvae and adults specimen were collected from each and every type of domestic and outskirt sites from the selected villages. These samples were further analyzed to know the status of larvae/adult and identify their presence/absence in the study area.

During the survey, dipping method was used to collect the larvae specimen and the collected sample were kept in the standard plastic tubes and brought into the laboratory for identifications and rearing. After that the collected larvae specimen were reared in standard plastics jars that are covered with cotton cloth containing the feed mixed with yeast and biscuit powder mixture (Joseph *et al.*, 2004, Das *et al.*, 2003; Helge *et al.*, 2002) [7, 4, 5]. All the collected speciman were brought to the laboratory for the species identification (Jagdish and Jagbir, 2003; Joshi, 2005) [6, 8]. Morphologically identification were done up to the species level with the help of standard references such as Roy and Brown (1971) [14]; Patel (2002) [10] and Sumit (2008) [16]. Collected data were analyzed to calculate the Larval Density (LD), average monthly and village wise larval and adult densities by using formula LD = number of larvae collected/ number of dips made while adult density was calculated as Man per Hour Density (MHD) by the formula MHD = Total number of mosquito collected / Total time of collection.

3. Results

The results of the study showed that the breeding of *Cx. quinquefasciatus* species of mosquitoes were found during field collection at the different breeding place of study sites in the rural areas around Rajkot. *Cx. quinquefasciatus* was predominantly outskirts breeder and found maximum to be as larvae (46%) from ditches. They were mainly preferred drainage water as a breeding habitat that having ample amount of vegetation, followed by chekdam (16%), rain pools (13%) and river (8%). Larvae of this species were also recorded from kind of domestic water collection like overhead tank (8%), ground tanks (5%) and pots (4%), except underground tank and small vessels (Table 1). Adults of the species were recorded from all the types of houses throughout the year. Among the domestic habitat Cemented houses (20%) were recorded more adults the clay houses (18%) and huts (15%) (Table 1). Outskirt habitat was recorded maximum average larval density of *Cx. quinquefasciatus* during the month of September in both the years (2006-07), while during the month of May in the both years (2006-07) the density was recorded minimum (Figure 2). Village wise results shows that the Madhapar village have maximum average larval density of the species was recorded in the month of Oct-06 and spe-07 while village Kankot amd village Sokhada have minimum average larval density of the species was recorded in the month of May in both the years (Figure 2).

Domestic habitat was also recorded maximum average larval density of *Cx. quinquefasciatus* during the month of September in both the years (2006-07), while during the month of May in the both years (2006-07) the density was recorded minimum (Figure 2). Village wise results shows

that the Madhapar village have maximum average larval density of the species was recorded in the month of Oct-06 and spe-07 while village Kankot and village Sokhada have minimum average larval density of the species was recorded in the month of May in both the years (Figure 3).

Table 1: Mosquito larvae breeding preference (in percent) and Day time resting habitat preference (in percent) of adult mosquito species at various habitats in the rural areas around Rajkot city during the year 2006-07

Breeding Habitats of *Cx. quinquefasciatus*				**Resting Habitats**	***Cx. quinquefasciatus***
Domestic		**Outskirt**		**Human Dwellings Houses without cattle**	
Ground tanks	**5%**	**Chekdam**	**-**	**Cemented Houses**	**20%**
Overhead	8%	Rivers	16%	clay Houses	18%
Earth pots	4%	Rain Pools	8%	Huts	15%
Small vessels	-	Stagnant waste water	13%	Mixed Dwellings Houses with Cattle	
Underground	-	Drainage***	46%	Cemented Houses	19%
		***Surface ditches drainage water		clay Houses	16%
				Huts	12%

Results of the *Cx. quinquefasciatus* average adult density was maximum recorded during Sept-06 and Aug-07 (24.25) and (24.41) respectively and minimum recorded during the month of May in both the years (2006-07) (Figure 4). Whereas the village wise maximum average adult density of *Cx. quinquefasciatus* was recorded from Naranka in the month of September of both years while minimum density was observed in Naranka village in the month of May in the years 2006 and 2007 (Figure 4).

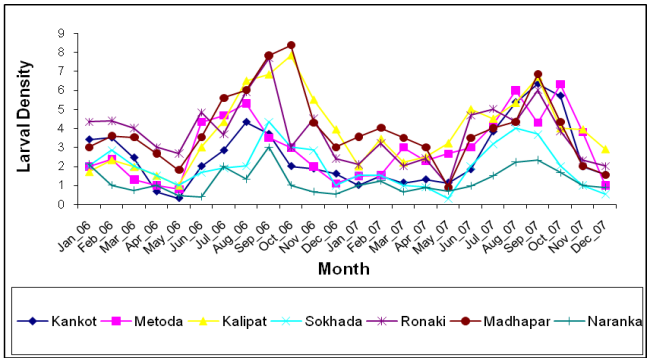

Fig 2: Month wise outskirt larval density (LD) per litre of sample water of mosquito *Culex quinquefasciatus* of villages surveyed around Rajkot city during 2006-07(n=24/village/month).

There are certain factors that have been effect on the mosquito's distribution and prevalence like season, temperature, water table and environmental conditions therefore we have compare the average adult density with rainfall and temperature in present study. The results of the present study shows that the maximum average adult density of the *Cx. quinquefasciatus* was recorded during the Sept-06 (24.25) and Sept-07 (24.41) whereas the rainfall in this month (September) was 5.70cm and 4.10cm and temperature was 28°C and 29°C recorded in the years 2006 and 2007 respectively. While the minimum average adult's density of *Cx. quinquefasciatus* was recorded during May-06 (13.67) and May-07 (12.12) while during this month there were no rainfall and the temperature was recorded 33°C and 34°C. Therefore, it was concluded from the study results that the seasonal conditions and environmental factors positively effect on the adult mosquito density.

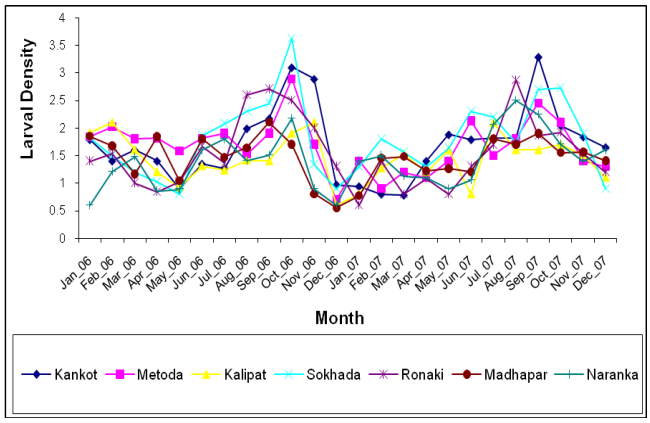

Fig 3: Month wise larval density (LD) per litre of sample water stored in tanks for domestic use of mosquito *Culex quinquefasciatus* of villages surveyed around Rajkot city during 2006-07(n=40/village/month).

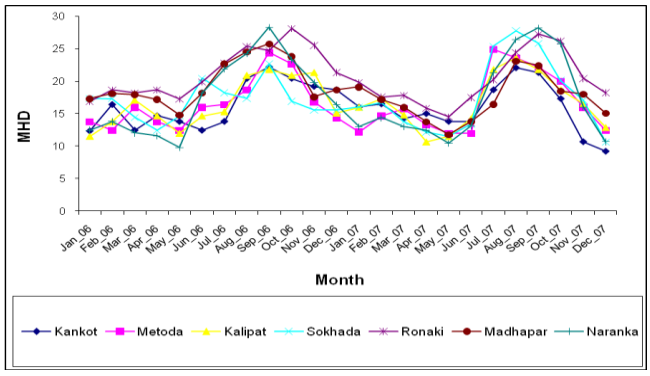

Fig 4: Month wise adult MHD (Man hour density) of *Culex quinquefasciatus* of villages surveyed around Rajkot city during 2006-07(n=9/village/month)

4. Discussion

The present study results clearly shows that the micro habitats (all village area) provide ideal breeding conditions for the *Cx. quinquefasciatus*. One of the important observations made during the study was that the water storage tanks buildup under the stair case which is the ideal for the mosquitoes to breed due to low sunlight penetration under the stair case and also controlled kind of environment.

The Aquatic vegetation in larval habitats may also affect the abundance of mosquito larvae by providing protection (Rajnikant *et al.,* 1996), while during the present study we have also observed that the mosquito's larvae were found more on the peripheral regions having vegetation. There are many studies suggested and recorded that the environmental factors like rainfall and temperature are considered as important factor for the breeding of mosquitoes and for disease transmission. (Alicia *et al.*, 2000, Joseph *et al*., 2004, Pemola and Jauhari, 2006) [1, 7, 12] and our present study results also recorded similarly.

The dependency of larval density and adult mosquitoes are upon the availability of breeding grounds and resting habitat in the particular area. Higher the numbers of breeding and resting sites more the density and mosquitoes and also vise a versa. For example, more human populated area means that provides additional blood meal opportunities and also more breeding habitats (Joseph *et al.,* 2004) [7].

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