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Seasonal and spatial abundance of *Aedes* mosquito depending upon the different kinds of meteorological parameter in five different districts of West Bengal, India

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Abstract
The present study is conducted to estimate the effect of several climatic parameters on the seasonal abundance of *Aedes* mosquitoes. Based on the distribution of previously reported dengue cases, initially five districts of West Bengal had been selected and a weekly ovitrap-surveillance is conducted for one year. After successful obtaining of specimen from the ovipositors site, the larvae has been brought to the laboratory and kept them into the different mosquito cages for future rearing and after emergence of adult, the mosquitoes has been heat fixed and identified by using Dewinter Stereo Zoom microscope. After proper identification of the specimen, the specimens has been curate on the appropriate levelled vials and then a simple mean and standard deviation were calculated for further statistical analysis. The Karl-Pearson coefficient correlation method is used to calculate statistical measurement. Comparing the correlation values among different kinds of environmental parameter, the r value of correlation between mosquito abundance and humidity exhibit much higher correlated specially in monsoon. On the above entomological survey, it has been observed that higher humidity and rainfall show the positive correlations with mosquito abundance and hence the effects on the spreading of DHF on proportional basis.

Keywords: *Aedes albopictus*, *Aedes aegypti*, DHF, temperature, humidity, rainfalls, correlations

1. Introduction
Mosquitoes are reputed to be enigmatic vectors of several diseases like Dengue, Malaria, Chikungunya, Filaria and Zika etc. affecting both human health and domestic animals [1]. Dengue is a vector borne disease transmitted by the day feeding *Aedes* mosquitoes. *Aedes aegypti* is an invasive arboviral vector transmitting diseases like dengue, chikungunya, zika and yellow fever where as *Aedes albopictus* is a competent vector of several viruses including dengue fever (Centre for Diseases Control And Prevention,2009) and Eastern equine encephalitis virus [4, 5]. *Aedes* mosquito mainly breeds in stagnant water and containers, where the female lays eggs and larvae hatching out from the laid eggs and remain there till they metamorphose into adult. *Aedes aegypti* can also breed indoors and can bite anyone throughout the day [6] but *Aedes albopictus* feeding peaks in the early morning and late afternoon and it mainly inhabits outdoor [7, 8].
Various lines of data clearly indicate the correlation between temperature, humidity and rainfall with the population density of *Aedes* mosquitoes, the causative vector of dengue fever [2, 3, 10] in several sites of South-east Asia. Incidence of dengue and dengue haemorrhagic fever(DHF) are profound in India both in urban and rural areas particularly following rainy season from July- October and infection of dengue decreases on and from November [9, 10, 11]. In India West Bengal is one of the most dengue epidemic regions as reported [12, 14] So, we aimed to investigate if there is any correlation exists between the tropical environment of five district of west Bengal (Howrah, Hooghly, Kolkata, North 24Pargana, and South24 Pargana) and abundance of *Aedes* mosquitoes.

2. Materials and Methods

In the present study, five districts of South Bengal were selected based on outbreak of dengue fever in the last two years. The larvae of *Ae*. *albopictus* were sampled from August 2018 to July 2019.

Larval stages of *Ae. albopictus* and *Ae*. *aegypti (*field generation, F_0) were collected from domestic container (tank) and peri domestic containers (plastic container, plastic bucket, plastic tub and food container of cow) and brought into the laboratory. Larvae were taken to the laboratory and their development (Larva-pupa- adult) occurs in the colony culture cage. The emerged adults were killed with ether and were identified as per the key of Leslie Rios *et al.*, 2004 [14].

2.1 Collection sites

Fig 1: Map representing the collection sites of study area

2.2 Descriptions of collection sites

Table 1: Descriptions of collection sites

District	Site of collections	Latitude	Longitude
Hooghly	Serampore	22.7505°N	88.3406°E
	Mogra	22.9870°N	88.3773°E
Howrah	Shibpore	22.5713°N	88.3109°E
Kolkata	Taltal(CentralKolkata)	22.5614°N	88.3584°E
	ParnashreePally, (Behala)	22.5062°N	88.3018°E
South 24 Parganas	Diamond Harbour	22.1987°N	88.2023°E
	Budge budge	22.4700°N	88.1646°E
North 24 Parganas	Dunlop	22.6519°N	88.3786°E
	Dumdum Cantonment	22.6345°N	88.4198°E
	Birati	22.6636°N	88.4273°E
	Madhyamgram	22.6924°N	88.4653°E
	Barasat	22.7248°N	88.4789°E
	Ashok Nagar	22.8384°N	88.6196°E

2.3 Collection of Larvae

Larvae were collected using glass droppers and were reared in the laboratory insectaries. Larvae were fed on biscuits pipettes on shallow plastic Petri plate with water which was changed daily until they pupated. Pupae were taken using same glass droppers and kept into the water in small container within mosquito cages. Emergence of adults from pupae occurred within the cage in 2-3 days.

2.4 Identification of species based on the external morphology

The Olympus microscope (XL) and a Dewinter stereo zoom microscope were used for the identification of the specimen. The collected larvae have been reared up to adult stage in the water taken from water bodies of the studied areas and specimens have been identified [13].

3. Observations

The field work has been undertaken during the month August 2018 to July 2019 in the following areas- Howrah (Shibpore, Santragachhi), Kolkata (Taltala, Behala), North 24 Pargana (Dunlop, Khardaha, Madhyamgram, Birati, Dumdum cantonment, Ashok Nagar, Barasat), Hooghly (Magra, Serampore), South 24 Pargana (Garia, Diamond Harbour). The larvae of *Aedes aegypti* and *Aedes albopictus* mosquitoes were collected from these areas. Larval stages of *Aedes albopictus* and *Aedes aegypti*(field generation, F_0) were collected from domestic container (tank) and peri domestic containers (plastic container, plastic bucket, plastic tub and food container, broken pot, waist tyre, and cement tub of cattle shed. The collected larvae were brought to the laboratory and their developmental (Egg-Larva-pupa- adult) process occurs in the colony culture cage. The emerged adults were killed with ether and were identified by using the key [4, 12]. The morphological variations (mouthparts, wings and colouration of abdomen) are observed by binocular and Compound light microscope [14]. The Collected data are given in the table below:

Table 2: Seasonal abundance of Larvae of *Aedes* mosquitoes of five districts in South Bengal (Duration: August 2018-July 2019)

Month (2018-2019)	Kolkata	Howrah	Hooghly	S.24 Parganas	N.24 Parganas	Mean
August	96	134	178	112	191	142.2
September	87	96	170	89	159	120.2
October	24	13	25	31	26	23.8
November	16	19	30	4	10	15.8
December	17	15	17	8	19	15.2
January	11	13	9	8	7	9.6
February	16	15	12	11	9	12.6
March	10	14	10	18	26	15.6
April	46	15	30	57	23	34.2
May	46	38	69	77	70	60
June	49	45	71	87	68	64
July	78	56	93	107	156	98

Table 3: Emergence chart of adults from the collected larvae (Duration: August 2018-July 2019)

Month	Kolkata		Howrah		Hooghly		N:24 Pargana		S:24 Pargana	
	Ae. albo	*Ae. aeg*	*Ae. albo*	*Ae. aeg*	*Ae. albo*	*Ae. aeg*	*Ae. albo*	*Ae. aeg*	*Ae. albo*	*Ae. aeg*
August	20	67	90	33	134	23	11	158	68	32
September	17	55	55	16	106	37	33	102	58	17
October	8	12	7	4	15	6	6	17	18	11
November	4	8	10	5	17	7	4	5	4	0
December	4	12	7	5	14	2	2	15	6	2
January	2	7	7	3	7	0	0	7	4	3
February	3	11	9	4	8	2	0	8	5	4
March	5	5	8	3	4	3	9	16	8	6
April	13	29	7	6	22	5	4	17	43	10
May	11	30	23	13	55	9	23	42	41	33
June	15	31	32	9	58	7	14	49	47	36
July	23	49	47	7	67	21	41	108	73	29
Total	125	316	302	108	507	122	147	544	375	183
Percentage	4.58	11.58	11.1	3.96	18.58	4.47	5.4	19.93	13.74	6.71

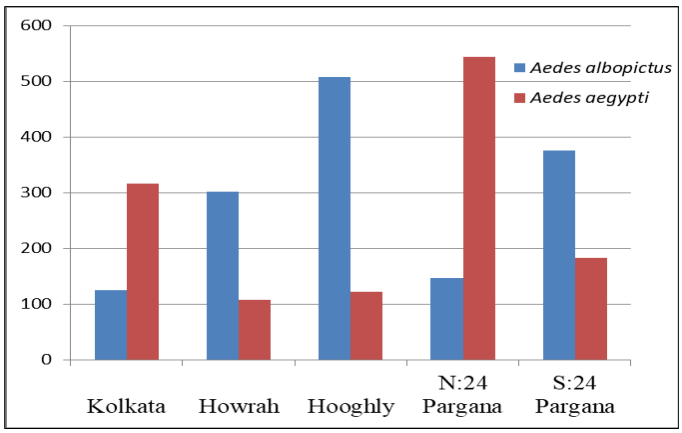

Fig 2: Diagrammatic representation of two different *Aedes* mosquitoes in five district of West Bengal

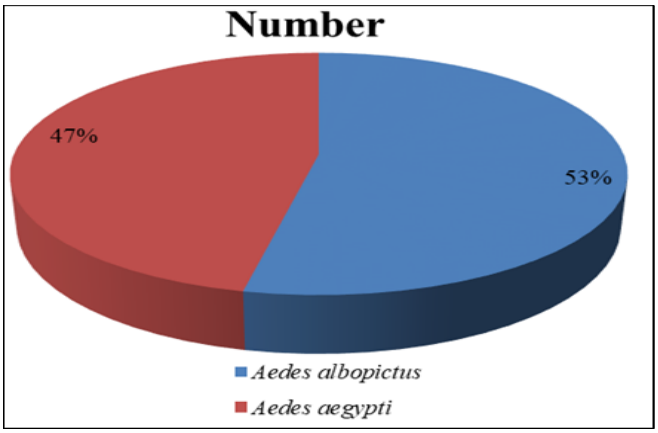

Fig 3: Pie chart is depicting abundance of two different *Aedes* mosquitoes in West Bengal

This research programme was conducted in rainy and dry seasons for an entire one-year period, since August 2018 to July 2019. The data were collected from different places, biotopes and natural habitat of mosquitoes of five districts of West Bengal that have already mentioned in above. A report of state health department has revealed that 44,852 dengue cases were reported from various southern districts of west Bengal and Kolkata (Businesses Standard, by press Trust of India, November12, 2019). Therefore, these threatened reports provoked researchers to investigate the population census of the actions as well as the surveyed areas has been marked as endemic region of DHF by the govt.

The observed/ collected data are furnished in the tables (Table: 3, 4, 5) given below: This survey was conducted in West Bengal based on DHF outbreak in past few years. (DHF report: Source Health and Family Welfare dept).

Table 4: Temperatures (ºC) of five districts in South Bengal (Duration: August 2018-July 2019)

Month	Kolkata	Howrah	Hooghly	S.24 Parganas	N.24 Parganas	Mean
August	28.6°	28.6°	28.8°	28.6°	29.5°	28.875°
September	28.9°	28.8°	29.0°	28.9°	29.0°	28.925°
October	27.4°	27.5°	27.4°	27.4°	27.5°	27.450°
November	23.3°	23.4°	23.4°	23.4°	24.5°	23.675°
December	19.5°	19.6°	19.6°	19.6°	20.0°	19.700°
January	19.5°	19.6°	19.5°	19.7°	19.0°	19.450°
February	22.0°	22.1°	22.0°	22.2°	22.5°	22.200°
March	27.0°	27.2°	27.2°	27.0°	27.5°	27.225°
April	29.9°	30.0°	30.1°	29.9°	30.0°	30.000°
May	30.4°	30.5°	30.6°	30.3°	30.5°	30.475°
June	29.7°	29.8°	29.9°	29.7°	30.0°	29.850°
July	28.9°	28.8°	28.9°	28.8°	29.0°	28.875°

Table 5: Relative Humidity (percentage) of five districts in South Bengal (Duration: August 2018-July 2019)

Month	Kolkata	Howrah	Hooghly	S.24 Parganas	N.24 Parganas	Mean
August	83	81	82	84	82	82.4
September	81	82	83	84	83	82.6
October	73	74	76	78	79	76
November	73	69	70	72	69	70.6
December	73	70	71	72	70	71.2
January	69	68	69	71	69	69.2
February	65	63	64	66	62	64
March	62	60	65	63	64	62.8
April	69	68	70	70	72	69.8
May	70	70	71	73	70	70.8
June	79	76	77	80	81	78.6
July	83	81	85	84	82	83

Table 6: Rainfall (mm) of five districts in South Bengal (Duration: August 2018-July 2019)

Month	Kolkata	Howrah	Hooghly	S.24 Parganas	N.24 Parganas	Mean
August	334	341	332	322	298	325.4
September	305	313	323	291	281	302.6
October	141	141	138	143	133	278.4
November	26	26	25	27	21	25
December	7	7	5	6	4	5.8
January	14	12	13	15	14	13.6
February	22	18	20	19	16	19
March	28	34	26	27	24	27.8
April	42	51	49	48	48	47.6
May	126	127	127	107	97	116.8
June	301	304	312	279	274	294
July	375	370	352	361	314	354.4

4. Calculations

The Karl Pearson's Coefficient of correlation was used to calculate the R-value of different statistical analysis. Thecorrelation between temperature, humidity, and rainfall and mosquito abundance is depicted on the tables (Table: 6, 7, 8) and figures(Fig No:4,5,6) given below.

Table 7: Correlations between abundance of *Aedes* mosquitoes and Humidity (percentage)

Month	Humidity	Abundance of Larvae	Correlation value(r)
August	82.4	142.2	0.84783533
September	82.6	120.2	
October	76	23.8	
November	70.6	15.8	
December	71.2	15.2	
January	69.2	9.6	
February	64	12.6	
March	62.8	15.6	
April	69.8	34.2	
May	70.8	60	
June	78.6	64	
July	83	98	

Table 8: Correlations between Abundance of *Aedes* mosquitoes and Annual Temperature (ºC)

Month	Temperature	Abundance of Larvae	Correlation value(r)
August	28.875	142.2	0.61410824
September	28.928	120.2	
October	27.45	23.8	
November	23.675	15.8	
December	19.7	15.2	
January	19.45	9.6	
February	22.2	12.6	
March	27.225	15.6	
April	30	34.2	
May	30.475	60	
June	29.85	64	
July	28.875	98	

Table 9: Correlations between Abundance of *Aedes* mosquitoes and mean Rainfall (mm)

Month	Rainfall(mm)	Abundance of Larvae	Correlation value(r)
August	325.4	142.2	0.81935826
September	302.6	120.2	
October	278.4	23.8	
November	25	15.8	
December	5.8	15.2	
January	13.6	9.6	
February	19	12.6	
March	27.8	15.6	
April	47.6	34.2	
May	116.8	60	
June	294	64	
July	354.4	98	

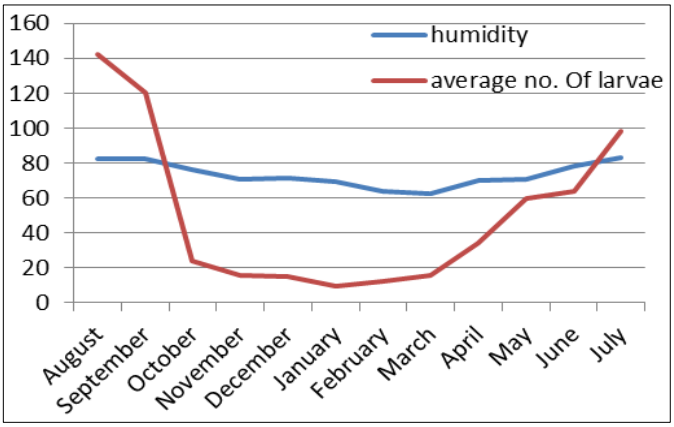

Fig 4: Line diagram representing the correlation between Humidity and *Aedes* abundance

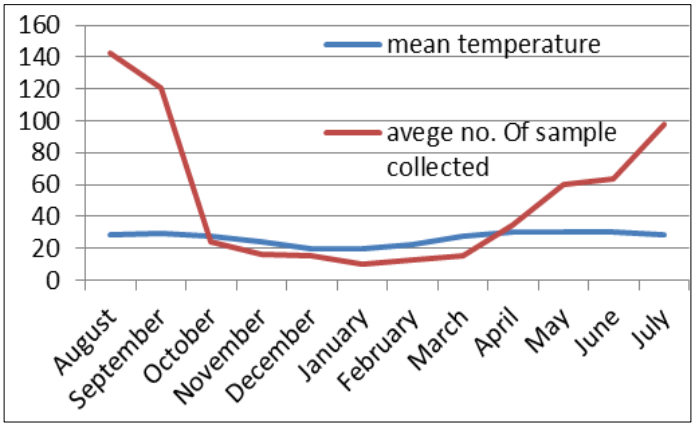

Fig 5: Line diagram representing the correlation between Temperature and *Aedes* abundance

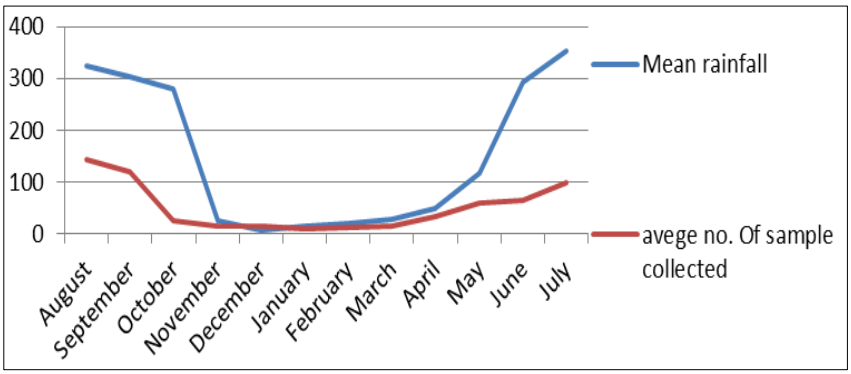

Fig 6: Line diagram representing the correlation between Mean rainfall and *Aedes* abundance

5. Results

Abundance of *Aedes* sp. of five districts in South Bengal is high in monsoon season i.e., from July to September. After September, the number of larvae starts decreasing and in winter i.e., from December to February, its abundance is lowest. Again, the number of larvae are tends to increase at

the advent of summer i.e., from April. The abundance of two different species of *Aedes* mosquitoes (*Aedes aegypti* and *Aedes albopictus*) in each of the five districts is depicted in Table 2. Present finding has revealed that the abundance of *Aedes albopictus* is high in Hooghly, Howrah and South 24 Parganas in comparison to the same of *Aedes aegypti*. Nevertheless, in Kolkata and North 24 Parganas, the abundance of *Aedes aegypti* is also very high. In figure 2, a column chart represents the comparison between the abundance of these two species in each of the five districts of South Bengal. In Fig 3, a Pie chart has indicated the abundance of these above-mentioned species in South Bengal. In table no 3, 4 and 5, average temperature, relative humidity and rainfall of each of the 12 months in each of the five districts is mentioned respectively. In table 6, Karl Pearson's Coefficient of Correlations between abundance of *Aedes* mosquitoes and relative humidity (%) is represented. It has been observed that coefficient of correlation between the above two is much higher and they are positively correlated. The Karl Pearson's Coefficient of Correlations between abundance of *Aedes* mosquitoes and average temperature is also high and with the increase of temperature, the average number of collected larvae is also increased (table 7) Table 8 denotes that, Karl Pearson's Coefficient of Correlations between abundance of *Aedes* mosquitoes and average rainfall. Here Karl Pearson's Coefficient of Correlations is much higher and they have shown the significant correlations.

Comparing the correlations values among different kinds of metrological Parameter and seasonal abundance of *Aedes* mosquitoes, the r-value (~0.85) of correlation between mosquito abundance and humidity exhibit much higher especially in monsoon. It has also been observed that r-value of correlation between temperature and abundance show lower value among them. High abundance occurs when higher rainfall, moderate to high temperature and higher humidity, as occur in one year survey.

6. Discussion

The above study also revealed that climate influences spatial and temporal extent of DHF. As environmental and climatic variables are interrelated, so it is difficult to assess each individual factor [10, 15]. But with increasing of global warming, the distribution and abundance of mosquitoes are increasing as they prefer the tropical weather. So, it is required to do future studies whether the survival and the activities of mosquitoes are climate depending factors or not [16].

7. Conclusion

Based on the above study, it can be concluded that the abundance of dengue vectors i.e., *Aedes albopictus* and *Aedes aegypti* are much higher in monsoon and post-monsoon seasons. So, the year bound study is serving a good advisable note to the concern government as well the common citizen, to conduct a firm mosquito elimination program especially in the above mentioned seasons to control the profusion of *Aedes* mosquitoes and protect the public health simultaneously.

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