Prevalence of Three Mosquito Vectors: *Anopheles, Culex* and *Aedes* in Some Areas of Hooghly West Bengal, India

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ABSTRACT

Several mosquito genera such as *Anopheles, Culex* and *Aedes* serve as vectors of numerous deadly diseases throughout the world. Prevalence of these diseases strongly coincides with the prevalence of their respective vectors. During the present study adult mosquitoes of three genera (*Anopheles, Culex* and *Aedes*) were collected from selected four cattle sheds and four human habitations in both rural and urban areas of Hooghly district, West Bengal through hand collection method employing four man hours (two for human habitations and two for cattle sheds) in the first week of every month throughout the year (Jan'18 - Dec'18). Environmental temperature, humidity were recorded and GPS location of the collection points were plotted on the study area map. Altogether 4754 *Anopheles* (56.36%), 3312 *Culex* (39.26%) and 369 *Aedes* (4.37%) mosquitoes were collected from rural areas and 3766 *Anopheles* (50.16%), 3302 *Culex* (44.38%) and 372 *Aedes* (5%) mosquitoes were collected from urban areas. *Anopheles* and *Culex* mosquitoes showed higher prevalence in cattle sheds than human habitations in both rural and urban areas, whereas reverse situation is shown by Aedes mosquitoes. Monthly prevalence of different species of *Anopheles* also showed a significant difference between rural and urban areas (p<0.01). This study indicated that *Anopheles* and *Culex* mosquitoes are more prevalent in cattle sheds besides human habitations. Present study will illuminate about the resting-habitats in relation to mosquito ecology so that proper management strategies may be taken with a view to prevent the mosquito borne diseases in the endemic areas of Hooghly District.

KEY WORDS: MOSQUITOES; PREVALENCE; HUMAN HABITATIONS; CATTLE SHEDS; DISEASE.

INTRODUCTION

Mosquitoes belonging to several genera mainly *Anopheles*, *Culex* and *Aedes* serves as nuisance vectors of numerous deadly diseases like malaria, filaria, dengue etc. occurring throughout the world (Mondal et al, 2015). Several species of *Anopheles* mosquitoes severs as a vector of different types of malaria in tropical and subtropical countries. *Anopheles gambiae* and *Anopheles funestus* serves as the main malarial vector in African countries (Lindh et al, 2005).Whereas *Anopheles culicifacies* serves as the main malarial vector in Asian countries (Chatterjee and Chandra, 2000;Chavshin et al, 2014; Lindh et al, 2015; Seal et al 2018).

It was reported that in some rural areas of Hooghly district, West Bengal *Anopheles subpictus* Grassi serves as the main malarial vector (Chatterjee and Chandra, 2000). Some *Culex* species mostly Culex *vishnui* group and *Culex quinquifasciatus* serves as a vector of Japanese encephalitis, lymphatic filariasis in many regions of India

(Kanojia et al 2003) and West Bengal also (Chandra et al, 2007; Azmi et al, 2015), whereas some species of *Aedes* mosquitoes like *Aedes aegypti* and *Aedes albopictus* globally transmits dengue fever (Gubler 2002). In all the cases adult female mosquitoes are responsible for the transmission of disease causing pathogens. So, the prevalence of these diseases is strongly coincides with the prevalence of two factors: one is the abundance of the respective vectors and second one is the introduction of the disease causing pathogens in the suitable host, which are mostly dependent on environmental conditions like temperature, humidity, rainfall, availability of suitable breeding grounds, (Khan et al, 2017).

For the purpose of management of diseases, adult control strategies are mostly used today, which uses several insecticides like DDT, malathion, pyrethroid to control the adult mosquitoes. In this regard it is very important to have a better knowledge about the ecology of mosquitoes especially their resting site preference and biting behavior throughout the different times of a year (Alten et al, 2000). Reports on prevalence of different mosquitoes in rural and urban areas of Hooghly district, West Bengal are very scanty. So, the present study has been aimed to determine the month wise prevalence of three genera of adult mosquito vectors like *Anopheles, Culex* and *Aedes* in some rural and urban areas of Hooghly district, West Bengal, India along with the species composition of anopheline mosquitoes and to find out their correlations with some environmental factors like temperature and humidity throughout the year. This study would have a great impact on better understanding of mosquito ecology and their proper management strategies in the study areas.

MATERIALS AND METHODS

The entire study was performed monthly for one year starting from January'2018 to December'2018.The entire study was carried out in some rural and urban areas of Hooghly district, West Bengal, India. For the collection of adult mosquitoes four human habitations and four cattle sheds were fixed in both rural and urban areas. The location of the study areas were recorded with a hand held GPS (Germin Etrex201 model) and thereafter these way points were superimposed on study area map and satellite image (Fig.1).

The adult mosquitoes were collected by hand collection method from four fixed human habitations and four cattle sheds in each of rural and urban areas of Hooghly. Four man hours (two for human habitations and two for cattle sheds) were employed for the collection of the adult mosquitoes and the collection was done in three different time periods (morning: 6 am - 8 am; afternoon: 4 pm - 6 pm and night: 10 pm-12 am) of the same day in the first week of every month. The duration of collection time was fifteen minutes in each place. Both the indoor biting and resting mosquitoes were collected in test tubes with a small piece of net plugged at mouth of the tubes and on the next day they were brought to the Parasitology and Microbiology Research Laboratory for their identification. The environmental temperature and humidity of the collection points were recorded by Fischer Scientific machine. In laboratory the mosquitoes were anesthetized by applying chloroform to cotton and plugging on the opening of the tubes containing adult mosquitoes.

Table 1: Month wise prevalence of three genus of mosquitoes (*Anopheles, Culex* and *Aedes*) in human habitations and cattle sheds in rural areas of Hooghly District (Day time: 6a.m-8a.m from Jan'2018-Dec'2018)

Month	Temperature (°C)	Humidity (%)	Anopheles		Culex		Aedes	
			H.H	C.S	H.H	C.S	H.H	C.S
January	14.0°C	58.1%	12	27	10	15	0	0
February	18.1°C	51.5%	36	88	20	28	08	04
March	27.4°C	62.1%	42	86	32	52	10	02
April	28.2°C	63.2%	48	64	62	94	05	08
May	29.4°C	67.7%	28	52	36	68	09	03
June	30.0°C	76.2%	36	64	48	74	18	02
July	29.2°C	79.7%	68	112	76	132	13	04
August	28.2°C	81.8%	82	146	92	156	18	03
September	28.7°C	77.0%	84	124	68	96	20	06
October	23.4°C	70.3%	40	56	36	48	28	15
November	22.6°C	66.7%	22	32	30	44	11	05
December	15.2°C	61.2%	15	18	37	42	0	0

*H.H- Human Habitation, C.S- Cattle Shed

Then the mosquitoes were shorted morphologically according to the genus under a dissecting binocular. The total number of *Anopheles, Culex* and *Aedes* mosquitoes were noted down. Then the collected *Anopheles* mosquitoes were sorted out according to the species following Nagpal and Sharma (1995) and their numbers were noted down. Statistical analysis was performed following Zar, (1999) using SPSS software version 16.0.

RESULTS AND DISCUSSION

The locations of cattle sheds and human habitations in rural and urban study areas are given in Figure 1. The distance between rural and urban areas was 37.72km (Figure 2). Total 4754 *Anopheles* (56.36%), 3312 Culex (39.26%) and 369 Aedes (4.37%) mosquitoes were collected from rural areas and 3766 *Anopheles* (50.16%), 3302 *Culex* (44.38%) and 372 *Aedes* (5%) mosquitoes were collected from urban areas throughout the year. Month wise prevalence of three genera of adult mosquitoes (*Anopheles*, *Culex* and *Aedes*) in human habitations and cattle sheds in rural areas and urban areas are given in Table 1-3 and in Table 4-6 respectively. During the whole study period *Anopheles* and *Culex* mosquitoes showed higher prevalence in cattle sheds (81.42±7.14 and 77.67±7.02 respectively) than human habitations (50.64±4.58 and 50.92±4.2 respectively) in rural areas which was statistically significant (p<0.01).

In case of urban areas the mean density of *Anopheles* and *Culex* mosquitoes were also significantly higher (p<0.01) in cattle sheds (62.53±5.23 and 63.25±4.6 respectively) than human habitations (42.08±3.90 and 43.14±3.41 respectively). Whereas in both rural and urban areas *Aedes* mosquitoes showed more prevalence (p<0.01) in

human habitations (7.25±1.24 and 7.0±1.08 respectively) than cattle sheds (3.0±0.72 and 3.33±0.83 respectively) in the study areas. There is no significant difference in the prevalence of total number *Anopheles* (p=0.289), *Culex* (p=0.058) and *Aedes* (p=0.949) mosquitoes between rural and urban areas. Prevalence of these three genus of mosquitoes showed positive correlation with environmental temperature and humidity. On the other hand *Anopheles* and *Culex* mosquitoes showed higher prevalence during night time in human habitations and cattle sheds in both rural and urban areas (Figure 3 & Figure 4) whereas prevalence of *Aedes* mosquitoes in night time is significantly lower than the day time in the study areas (Figure 5).

Species composition of *Anopheles* mosquitoes showed a significant difference (p<0.01) in different months of the year, which also differ among rural and urban regions of the study area (Figure 6 & Figure 7). Four species of *Anopheles* mosquitoes were recorded in both rural and urban areas: *An. barbirostris*, *An. subpictus*, *An. annularis* and *An. vagus*. Monthly prevalence of different species of *Anopheles* also showed a significant difference between rural and urban areas (p < 0.01). In case of rural areas the peak month of prevalence of *An. barbirostris* was recorded during the month of January whereas in case of urban areas the prevalence of this species was found to be very low throughout the year. *An. subpictus* was more prevalent in rural areas than urban sites. This mosquito species showed two peaks, one during June-July and another during September-October in rural areas. Prevalence of *An. annularis* and *An. vagus* found to be high in urban areas in comparison with rural areas.

During the winter season starting from November to

Table 2: Month wise prevalence of three genus of mosquitoes (*Anopheles, Culex and Aedes*) in human habitations and cattle sheds in rural areas of Hooghly District (Dusk time: 4p.m-6p.m from Jan'2018-Dec'2018)

Month	Temperature (°C)	Humidity (%)	Anopheles		Culex		Aedes	
			H.H	C.S	H.H	C.S	H.H	C.S
January	18.0°C	59.3%	19	32	15	21	0	0
February	21.4°C	56.6%	56	96	28	44	05	0
March	28.7°C	60.4%	68	124	38	56	09	0
April	29.8°C	68.7%	68	82	82	120	05	07
May	30.7°C	62.5%	34	58	44	72	10	05
June	32.1°C	71.4%	44	76	56	80	16	03
July	30.8°C	73.5%	72	122	82	144	10	18
August	28.7°C	78.2%	84	136	86	132	0	0
September	29.8°C	75.0%	96	132	72	98	17	09
October	24.0°C	66.4%	48	64	56	64	21	04
November	23.2°C	66.6%	24	38	36	56	08	07
December	21.6°C	62.7%	14	22	40	46	0	0

*H.H- Human Habitation, C.S- Cattle Shed

January there is a sharp decline in the prevalence of all of the three genera of mosquitoes which reflects to the fact that there are some strong correlation between the mosquito oviposition to egg hatching with the environmental temperature.

In a field study at Gorakhpur district of Uttar Pradesh, Kanojia et al (2003) observed that there was a short peak of *Culex quinquifasciatus* in the month of March and a long peak of *Culex tritaeniorhynchus* in the month of September. They concluded that abundance of this species was related with rice cultivation as because they are mainly paddy field breeders. The present study also recorded higher abundance of *Culex* and *Anopheles* mosquitoes in the month of August, which may be due to the much availability of breeding sites during this time. Reports of several studies indicated that *Culex quinquifasciatus* as the most house frequenting mosquitoes, their prevalence in human habitations is higher than the cattle sheds (Chandra et al, 2013; Azmi et al, 2015).

Table 3: Month wise prevalence of three genus of mosquitoes (*Anopheles, Culex* and *Aedes*) in human habitations and cattle sheds in rural areas of Hooghly District (Night time: 10p.m-12a.m from Jan'2018-Dec'2018)

Month	Temperature (°C)	Humidity (%)	Number of collected Mosquitoes					
			Anopheles		*Culex*		*Aedes*	
			H.H	C.S	H.H	C.S	H.H	C.S
January	12.5°C	57.2%	16	21	15	18	0	0
February	20.1°C	58.7%	40	108	24	40	0	0
March	29.0°C	63.6%	86	146	36	112	03	0
April	30.1°C	65.4%	56	76	70	102	02	0
May	30.5°C	69.2%	48	72	56	80	0	0
June	32.2°C	78.7%	54	84	56	88	02	01
July	30.4°C	73.8%	84	146	96	172	04	02
August	28.9°C	76.5%	94	152	100	156	0	0
September	28.3°C	72.0%	112	146	88	108	04	0
October	23.2°C	60.6%	56	68	48	56	05	0
November	23.7°C	62.2%	28	46	32	44	0	0
December	19.8°C	56.9%	09	15	30	38	0	0

*H.H- Human Habitation, C.S- Cattle Shed

Table 4: Month wise prevalence of three genus of mosquitoes (*Anopheles, Culex and Aedes*) in human habitations and cattle sheds in urban areas of Hooghly District (Day time: 6a.m-8a.m from Jan'2018-Dec'2018)

Month	Temperature (°C)	Humidity (%)	Number of collected Mosquitoes					
			Anopheles		*Culex*		*Aedes*	
			H.H	C.S	H.H	C.S	H.H	C.S
January	13.8°C	55.9%	14	27	19	29	0	0
February	19.8°C	57.6%	28	40	16	36	0	0
March	28.4°C	60.1%	38	56	48	42	10	0
April	31.4°C	66.5%	32	56	40	68	8	0
May	29.6°C	66.2%	22	36	28	56	11	04
June	30.2°C	68.7%	24	46	42	56	12	03
July	29.5°C	75.2%	48	88	56	96	12	02
August	29.1°C	74.2%	66	112	82	106	12	06
September	26.7°C	75.2%	72	96	56	68	09	0
October	26.6°C	66.2%	36	48	28	36	16	08
November	24.7°C	62.4%	20	28	26	34	21	12
December	20.3°C	58.5%	08	16	25	38	0	0

*H.H- Human Habitation, C.S- Cattle Shed

Table 5: Month wise prevalence of three genus of mosquitoes (*Anopheles, Culex* and *Aedes)* in human habitations and cattle sheds in urban areas of Hooghly District (Dusk time: 4p.m-6p.m, Jan'2018-Dec'2018)

Month	Temperature (°C)	Humidity (%)	Number of collected Mosquitoes					
			Anopheles		*Culex*		*Aedes*	
			H.H	C.S	H.H	C.S	H.H	C.S
January	15.9°C	59.2%	18	29	16	36	0	0
February	23.3°C	57.8%	44	72	24	44	0	0
March	32.3°C	62.2%	58	96	28	46	0	0
April	30.5°C	62.7%	58	68	52	66	12	6
May	31.7°C	63.4%	28	48	38	62	12	8
June	33.7°C	72.3%	36	68	42	64	14	10
July	32.1°C	77.3%	64	96	72	104	8	16
August	29.6°C	76.8%	76	114	88	112	16	18
September	28.0°C	78.7%	64	84	58	88	16	09
October	27.7°C	64.6%	44	56	40	56	20	10
November	25.9°C	58.2%	24	36	32	46	04	0
December	20.7°C	55.9%	16	30	30	51	0	0

*H.H- Human Habitation, C.S- Cattle Shed

Table 6: Month wise prevalence of three genus of mosquitoes (*Anopheles, Culex* and *Aedes*) in human habitations and cattle sheds in urban areas of Hooghly District (Night time: 10p.m-12a.m, Jan'2018-Dec'2018)

Month	Temperature (°C)	Humidity (%)	Number of collected Mosquitoes					
			Anopheles		*Culex*		*Aedes*	
			H.H	C.S	H.H	C.S	H.H	C.S
January	11.6°C	58.9%	11	17	19	18	0	0
February	21.2°C	59.4%	24	36	16	28	0	0
March	30.0°C	63.5%	64	106	42	82	03	0
April	29.8°C	66.5%	52	74	62	92	09	0
May	31.9°C	66.6%	42	66	48	72	06	03
June	30.3°C	68.7%	46	66	38	72	0	0
July	28.6°C	76.2%	72	92	66	112	0	0
August	29.7°C	72.6%	84	122	92	128	08	0
September	27.8°C	75.6%	104	116	72	88	0	0
October	24.2°C	68.4%	44	64	36	48	04	05
November	23.5°C	62.5%	24	28	34	48	09	0
December	19.9°C	60.5%	10	18	42	49	0	0

*H.H- Human Habitation, C.S- Cattle Shed

The present study recorded higher prevalence of *Culex* and *Anopheles* mosquitoes in cattle sheds than human habitations in both rural and urban areas of Hooghly, West Bengal. It may be due to their resting habitat preferences in cattle sheds or zoophilic nature. As in many areas mosquito control strategy involves the control of adult mosquitoes by spraying insecticides, so it is very much necessary to have a better knowledge about the mosquito ecology, their biting behavior and resting habitat preferences.

The present study found that in the rural and urban areas of Hooghly district, West Bengal, among three mosquito genera, the abundance of *Anopheles* and *Culex* is more than the *Aedes* throughout the year. Besides this although the prevalence of *Aedes* mosquitoes was less but they prefer to rest in human habitations than cattle sheds which throw a light on their anthropophilic behavior. On the other hand *Culex* and *Anopheles* mosquitoes prefer to rest more in cattle sheds than human habitations in both rural and urban areas which indicated that they also prefer to feed cattle blood besides human blood.

Species composition of *Anopheles* mosquitoes were different in case of rural and urban areas of Hooghly. *An. subpictus* is more dominant species in the rural areas where as *An. vagus* found to be more prevalent in urban regions of Hooghly. *Anopheles subpictus* Grassi has been incriminated as a primary vector of malaria in rural areas of Hooghly, West Bengal (Chatterjee et al, 2000). The present study recorded two peak months of prevalence of this vector, one during June-July and another during September-October, which strongly coincides with the emergence of malaria in the study areas.

Figure 1: Location map of the study areas
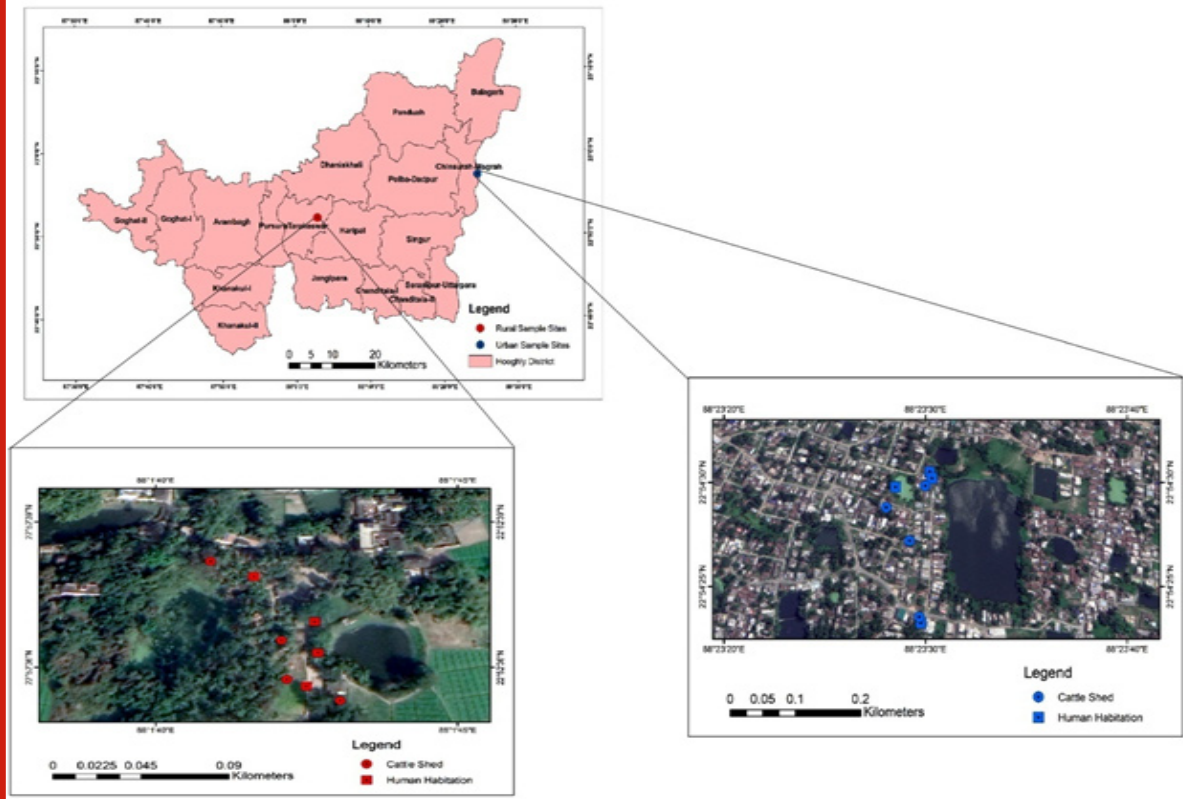
Figure 2: Distance between rural and urban sample sites
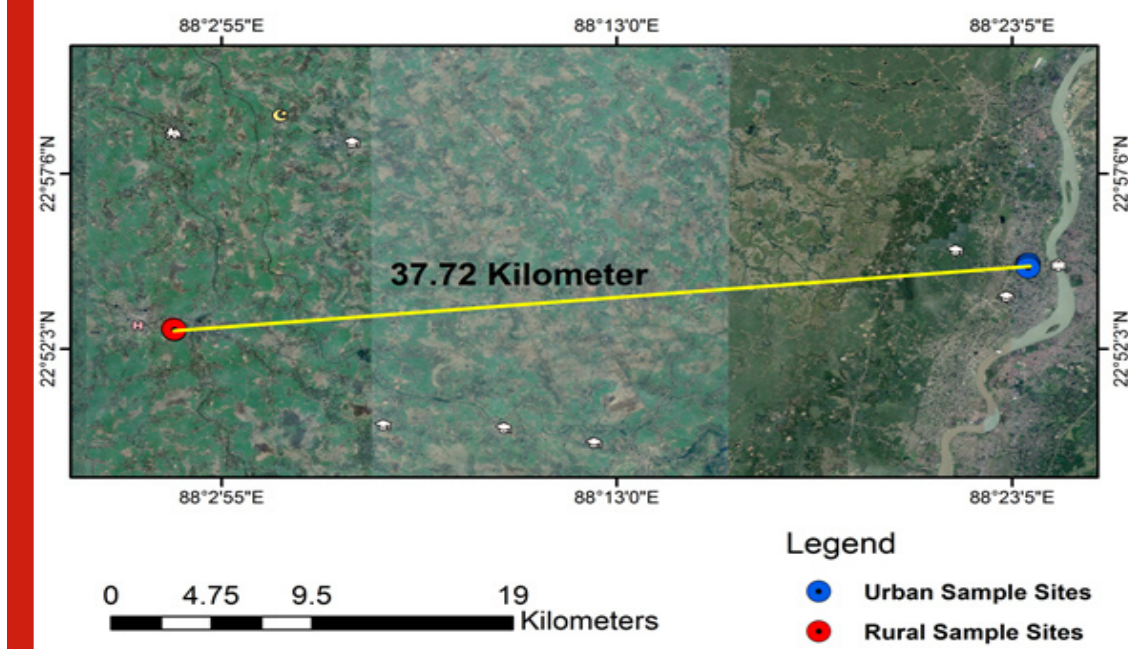
Figure 3: Percentage of *Anopheles* mosquitoes collected in three different times from Human habitations and Cattle sheds of Rural & Urban areas of Hooghly District (Jan'2018–Dec'2018).
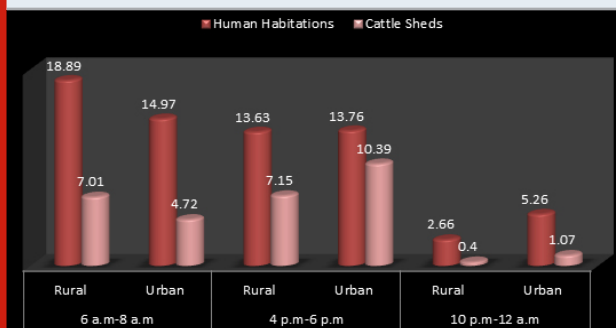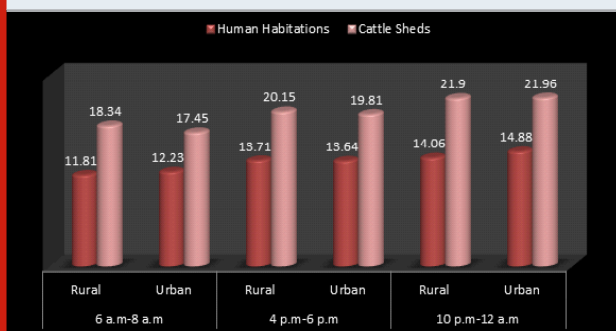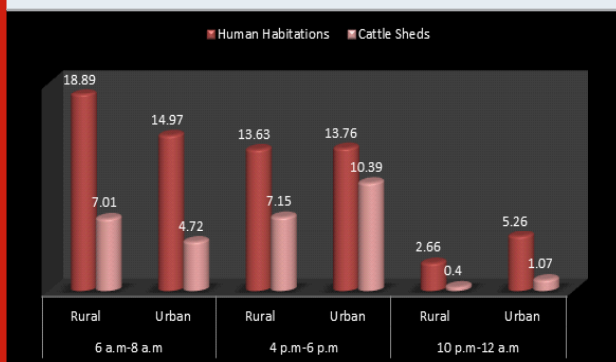

Figure 4: Percentage of *Culex* mosquitoes collected in three different times from Human habitations and Cattle sheds of Rural & Urban areas of Hooghly District (Jan'2018–Dec'2018).

Figure 5: Percentage of *Aedes* mosquitoes collected in three different times from Human habitations and Cattle sheds of Rural & Urban areas of Hooghly District (Jan'2018–Dec'2018).

Figure 6: Month wise species composition of *Anopheles* mosquitoes in rural areas of Hooghly district (Jan'2018–Dec'2018).
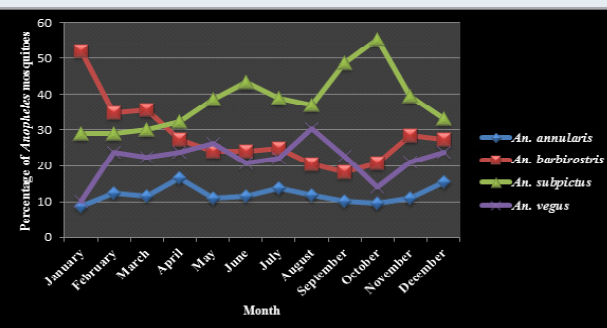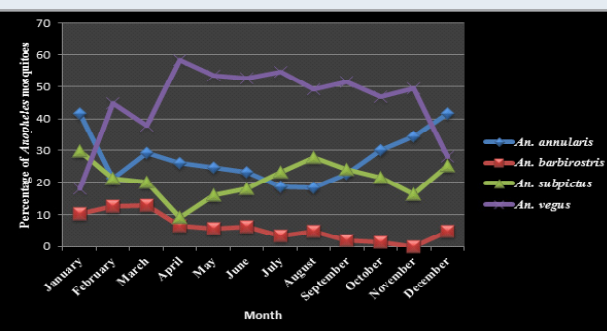

Figure 7: Month wise species composition of *Anopheles* mosquitoes in urban areas of Hooghly district (Jan'2018–Dec'2018)

cattle sheds also during the application of insecticides to control the adult mosquitoes. Present study will illuminate about the resting-habitats of three genera of mosquitoes in relation to mosquito ecology so that proper management strategies may be taken with a view to prevent the mosquito borne diseases in the endemic areas of Hooghly District.

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Conflict of interest: The authors declare that they have no conflict of interest.

CONCLUSION

Present findings are highly significant in understanding the mosquito ecology in the study areas and to have a better knowledge on their resting habitat preferences. This study has indicated that *Anopheles* and *Culex* mosquitoes are more prevalent in cattle sheds besides human habitations. So, much care must be taken in the

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