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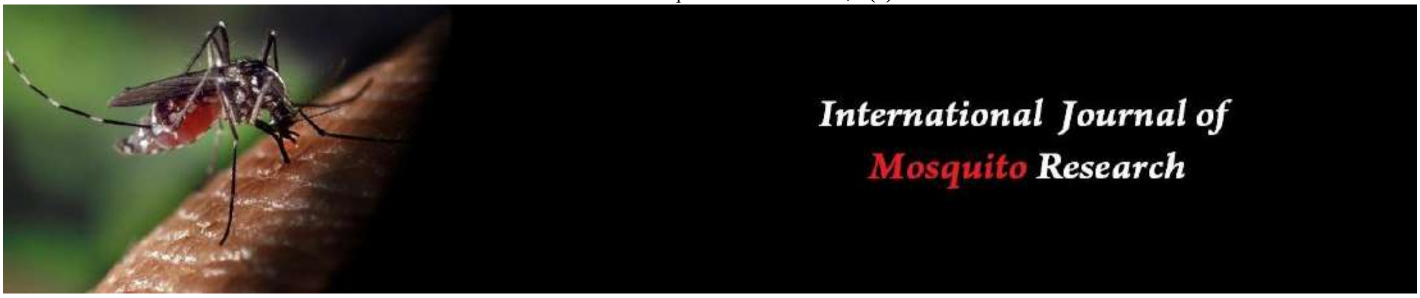

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Influence of nature in controlling filarial transmission: A study in slums of Burdwan

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Abstract
Purpose: Lymphatic filariasis is a crippling disease which affects the health status as well as economic condition of a person and also the society. Many attempts are made by scientists all over the world to control the filarial worm as well as vector. But nature plays important role in controlling the filariasis.
Methods: To have some clear picture on how nature helps to control transmission of filarial disease, four slums of Burdwan (Hatgobindapur, Pandaveswar, Jamuria and Memari) were sampled for Daily survival rate (DSR), Daily Mortality Rate (DMR), Presumptive Mortality Rate (PMR) and Ovariolar dilatatations.
Results: Lack of synchronization between the highest vector density and transmission disease, fall in parasitic load, mortality between two successive gonotrophic cycles, rise and fall in temperature and humidity is noticed in all the four slums which help to keep the check on transmission level of filaria by nature itself.
Conclusions: Factors behind the natural phenomena of control is reflected in this article which perhaps helps to adopt strategies for effective control.

Keywords: Filaria, control, burdwan, slums, nature

Introduction
The lymphatic filariasis is a public health problem, and it is of great concern today. It is a painful, disfiguring disease. It is debilitating diseases and affects the socioeconomic status of human as most of the affected persons are morbid. The main parasites are *Wuchereria bancrofti, Brugia malayi* and *Brugia timori*. The main vectors are the species of the genera *Culex*, and *Mansonia*. At least 1307 million people in 83 countries including 553.7 million people in India are at risk [1-2].
Information regarding the epidemiology of filaria is recorded from different parts of West Bengal by different scientists from time to time [3-13].
Effects related with environmental change profound in modulating natural ecosystems. Climate change coupled with rapid urbanization is stimulating unprecedented change in population dynamics and status of mosquito borne diseases [14]. Scientists over different parts of the world trying their best to control the filarial parasites by applying different modes of control mainly by reducing both the vector and parasite populations through different means. But still the outcome of the program is not so much satisfactory. But nature itself plays important role in controlling the parasites [15-16]. So, we can avail ourselves of natural control of filariasis simply by controlling indiscriminate urbanization, controlling deforestation, proper sanitization and reducing the source of vector mosquito to breed. Ecological transformations, rapid and uncoordinated urbanizations of rural area mainly due to the construction of dams, irrigation canals, poor design and lack of maintenance of sewage water, water storage tanks and urban subsistence agriculture can facilitate increase of vector population transmitting filaria and other vector borne diseases [17-18]. In the year 1975 the proportion of urban dwellers in the least developed countries was only 27% which rose to 40% by the year 2000. Fifty percent of the world's urban population is concentrated in Asia. Currently, the annual growth rate in Asian cities is 2.7% [19]. This implies that in the future, an increasing number of habitats with organically polluted water will be available for *Culex* vectors [20].
This paper highlights on how nature plays important role in controlling the filarial outbreak in slums (Hatgobindapur, Pandaveswar, Jamuria and Memari) of Burdwan District, West Bengal, India.

Materials and Methods

Indoor resting mosquitoes were collected in the morning, once in a month from 10 fixed human habitations (shelters) of four slums (Hatgobindapur (23.25°C N, 87.97°C E), Pandaveswar (23.70°C N, 87.27°C E), Jamuria (23.70°C N, 87.07°C E) and Memari (23.17°C N, 88.10°C E) of Burdwan, West Bengal, India from March 2018 to February 2020. Collections were made in all the seasons of the year namely summer (March-June), Rainy (July-October), winter (November-February) following the method of De and Chandra [21]. We have visited slums once in a month thus 12 times in a year having 10 shelters. Thus in two year we have visited 240 shelters in each slum. Thus in two year we have visited 960 shelters in four slums. We have also collected data from meterological department regarding maximum and minimum temperature and rainfall. Collected mosquitoes were identified and *Culex quinquefasciatus* were dissected for the search of developing filarial larvae including microfilariae (*mf*). Ovariolar dilatations of mosquitoes were examined by the method of Polovodova [22] which were collected in the morning hours from all the four slums in all the three seasons. DSR and DMR were calculated with the method of Davidson [23] and Service [24] and PMR between two successive age groups were calculated by the help of method of Gillies and Wilkes [25]. Statistical analysis was done using Students t-test [26]. Standardized effect size is calculated by using Cohen's d which is calculated by dividing the mean difference by the observed standard deviation. Assumption check under normality is also done using free software JASP (0.12.2) which mainly tests the null hypothesis that the dependent variable is normally distributed.

Results

Rainy season was found to be the high time for transmission of filarial disease in slums of Burdwan which is established by its highest infection and infectivity rates of the vector in nature and also the developmental period is short (Table 1). When seasonal variations of vector population were assessed, density was found to be significantly lower (P>0.05) in the rainy season in comparisons to other seasons in all the slums.

Number of *Cx. quinquefascitus* infected with *mf*, first, second, and third stage larvae of *W. bancrofti* gradually declines in all the slums (Table 2). It indicates that all the *mf* that enter into the GI tract of mosquito cannot develop into L3 stage.

A high percentage of mortality of vector population collected from all the four slums of Burdwan was observed between two successive gonotrophic cycles (Table 3). Most of the mosquitoes carrying *mf* were found to be nulliparous (yet to lay first batches of eggs) i.e. took *mf* during their first blood meal. Results of statistical analysis regarding one sample student t test, descriptive and assumption checks of Vector Prevalence, Vector infection rate, Vector Infectivity Rate and Parasitic Load is presented in Table 4. The computed $t_{0.05(3)}$ for vector prevalence for different seasons (summer, rainy, and winter) are 10.698, 4.387 and 11.075; for vector infection rate the values are 2.970, 2.630 and 3.493; for vector infectivity rate the values are 3.555, 3.638 and 1.732; and for parasitic load the t value for *mf* is 9.966, for 1st stage, it is 6.328, for 2nd stage it is 5.551 and for 3rd stage the value is 2.774 respectively and all the values are far high from tabulated $t_{0.05(3)}$ value 2.353. So, the probability P of the H_0 being correct is lower than 0.05 (P<0.05). It is considered too low. So the H_0 is rejected and it is inferred there is significant difference.

Cohen's d provides standardized method for comparing results. It describes the mean of the two groups normalized to pool SD of the two groups. The Cohen's d value of vector prevalence for different seasons (summer, rainy, and winter) are 5.349, 2.194 and 5.537; for vector infection rate the values are 1.485, 1.315 and 1.747; for vector infectivity rate the values are 1.778, 1.819 and 0.866; and for parasitic load of *mf* the value is 4.983, for 1st stage, it is 3.164, for 2nd stage it is 2.775 and for 3rd stage the value is 1.387 respectively.

The Shapiro-Wilk test values for vector prevalence for different seasons (summer, rainy and winter) are 0.822, 0.928 and 0.775 respectively, for vector infection rate the values are 0.862, 0.843 and 0.969 respectively; for vector infectivity rate the values are 0.862, 0.821 and 0.729 respectively and the values for parasitic load of mf is 0.986, 1st stage 0.915, 2nd stage 0.928 and for 3rd stage 0.908 respectively and the values was not significant for vector prevalence, vector infection rate and vector infectivity rate in different seasons, and the data were normally distributed (P>0.05) and in similar manner the values for mf, 1ststage, 2nd stage and 3rd stage the values were not significant, and the data was normally distributed (P>0.05).

Maximum and minimum temperature, rainfall, humidity and, number of *Cx. quinquefasciatus* average of two year (March 2018 to February 2020) is plotted in Figure 1.

Table 1: Season wise vector prevalence, infection rate, infectivity rate and duration of parasitic development in vector *Cx. quinquefasciatus* in slums of Burdwan

Seasons	Slums	Summer	Rainy	Winter
Vector prevalence (*Cx. quinquefasciatus*) %	Hatgobindapur	28.75	26.82	31.45
	Pandaveswar	41.30	32.07	43.44
	Jamuria	40.09	38.04	42.41
	Memari	30.08	9.78	31.22
Vector infection Rate (*Cx. quinquefasciatus*) %	Hatgobindapur	1.25	3.99	0.68
	Pandaveswar	1.82	7.77	0.87
	Jamuria	0.45	1.68	0.38
	Memari	0.45	1.68	0.19
Vector infectivity Rate (*Cx. quinquefasciatus*) %	Hatgobindapur	0.22	1.05	0.19
	Pandaveswar	0.34	1.26	0.19
	Jamuria	0.11	0.42	0
	Memari	0.11	0.42	0
Developmental period (Days)	All slum average	3.96	3.71	5.83

Table 2: Gradual fall in Parasitic Load

Area		Average load per infected mosquito vector *mf*		
Slums of Burdwan	***mf***	**1st Stage**	**2nd Stage**	**3rd Stage**
Hatgobindapur	4.80	3.00	2.00	1.04
Pandaveswar	4.00	3.50	3.00	1.54
Jamuria	3.50	2.78	1.67	1.00
Memari	3.00	1.50	1.33	0.00

Table 3: Average presumptive mortality rate of Cx. *quinquefasciatus*, population between two successive gonotrophic cycles

Area	Parity					
Slums of Burdwan	**NP**	**P1**	**P2**	**P3**	**P4**	**P5**
Hatgobindapur	51.35	44.44	40.00	33.33	25.00	
Pandaveswar	50.00	40.00	37.50	33.33	30.00	
Jamuria	55.56	50.00	45.00	36.36	28.57	
Memari	4.0	50.00	40.00	33.33	25.00	

Table 4: One sample student t test, descriptives and assumption checks of Vector Prevalence, Vector infection rate, Vector Infectivity Rate and Parasitic Load

a. Vector Prevalence
One Sample t test

Season	t	df	p	Cohen's d
Summer	10.698	3	0.002	5.349
Rainy	4.387	3	0.022	2.194
Winter	11.075	3	0.002	5.537

Descriptives

Season	N	Mean	SD	SE
Summer	4	35.055	6.554	3.277
Rainy	4	26.677	12.162	6.081
Winter	4	37.130	6.705	3.353

Assumption Checks
Test of Normality (Shapiro- Wilk)

Season	W	p
Summer	0.822	0.147
Rainy	0.928	0.584
Winter	0.775	0.064

b. Vector Infection Rate
One Sample t test

Season	t	df	p	Cohen's d
Summer	2.970	3	0.059	1.485
Rainy	2.630	3	0.078	1.315
Winter	3.493	3	0.040	1.747

Descriptives

Season	N	Mean	SD	SE
Summer	4	0.993	0.668	0.334
Rainy	4	3.780	2.874	1.437
Winter	4	0.530	0.303	0.152

Assumption Checks
Test of Normality (Shapiro- Wilk)

Season	W	p
Summer	0.862	0.267
Rainy	0.843	0.203
Winter	0.969	0.833

c. Vector Infectivity Rate
One Sample t test

Season	t	df	p	Cohen's d
Summer	3.555	3	0.038	1.778
Rainy	3.638	3	0.036	1.819
Winter	1.732	3	0.182	0.866

Descriptives

Season	N	Mean	SD	SE
Summer	4	0.195	0.110	0.055
Rainy	4	0.787	0.433	0.216
Winter	4	0.095	0.110	0.055

Assumption Checks
Test of Normality (Shapiro- Wilk)

Season	W	p
Summer	0.862	0.266
Rainy	0.827	0.161
Winter	0.729	0.024

d. Parasitic Load
One Sample t test

Season	t	df	p	Cohen's d
mf	9.966	3	0.002	4.983
1st stage	6.328	3	0.008	3.164
2nd Stage	5.551	3	0.012	2.775
3rd Stage	2.774	3	0.069	1.387

Descriptives

Season	N	Mean	SD	SE
mf	4	3.825	0.768	0.384
1st stage	4	2.695	0.852	0.426
2nd Stage	4	2.000	0.721	0.360
3rd Stage	4	0.895	0.645	0.323

Assumption Checks
Test of Normality (Shapiro- Wilk)

Season	W	p
mf	0.986	0.937
1st stage	0.915	0.509
2nd Stage	0.928	0.585
3rd Stage	0.908	0.472

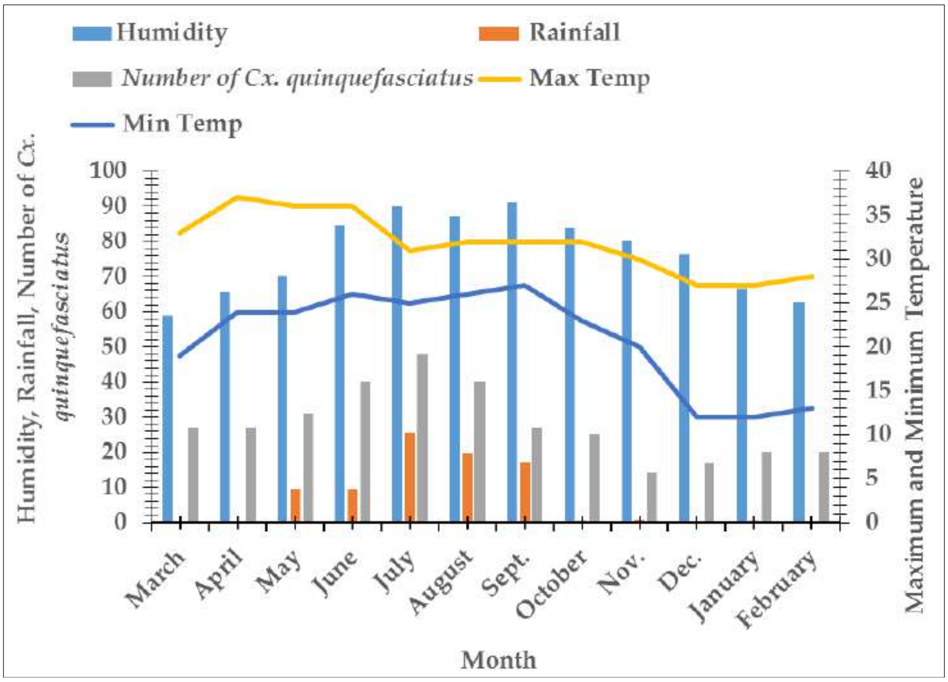

Fig 1: Maximum and minimum temperature, rainfall, humidity and number of *Cx. quinquefasciatus* average of two year (March 2018 to February 2020)

Discussions

Density of vector is found to be significantly lower in rainy season perhaps their breeding places might flooded during rainy season in comparison to other seasons[16] than other and developmental period is also shorter than other season but infection and infectivity rate is high in rainy season which indicates that there is lack of synchronization between highest vector density and transmission disease which helps to keep check on transmission level of filaria by nature itself.

Fall in parasitic load indicates that mf are damaged by the buccopharyngeal armature of the vector mosquito during the process of ingestion [27]. Sometimes it is also noticed that migrating *mf* are rapidly excreted by vector mosquitoes, thus limiting them [28-29].

A high mortality between two successive gonotrophic cycles caused reduction of vector as well as parasite population naturally [3-11].

Rise and fall in temperature and humidity leads to deformity and degeneration of large number of parasites in the body of the mosquito [30] itself and thus it limits the transmission of filarial disease. Moreover in the natural conditions where the mosquito lay eggs there are number of predatory fishes which feeds on mosquito immature and destroy them [31-57]. Besides fish arthropod larvae [58-63] also plays role in controlling mosquito population under control. We can easily control vector population simply by undisturbing environment. Rapid urbanization, deforestation disturbs nature. We can easily help us by helping nature in retaining its own features avoiding manipulations of nature.

Conflict of Interest

We declare that we have no conflict of interest.

Ethical approval

This article is not under consideration or published elsewhere. Ethical clearance for the study was obtained from IAEC, Approval No. 23/IAEC (06)/RNLKWC/2020, Dated 08.02.2020.

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Authors Contribution: IB: Data curation, Writing Original Draft, Statistical analysis **BM:** Reviewing, Editing **PPC:** Designing, Monitoring, Reviewing, Communication.

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