Annual population rhythm of *Anopheles* mosquitoes in Indian subcontinent

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Abstract

Several organism show a rhythm based behavior in their life. Mosquitoes are surviving successfully since ancient time on earth while lots of biological creatures have been extinct. Thus it is interesting to study their population load. Climatic conditions affect mosquito population significantly so on the basis of malaria cases their population is estimated in present study in Indian geographical scenario. In this study it was found that their annual population load show a scientific rhythm. A schematic wave form representation is also presented here to show mosquito population load. This study will be helpful in malaria vector eradication and health care policies.

Introduction

Like other mosquitoes *anopheles* mosquitoes also complete their life cycle within a year (around 45 days). During a year their populations load does not show uniformity and greatly affected by climatic factors of concerned geographical area. Even lab reared mosquito cultures do not show such population load uniformity round the year despite enjoying artificially provided climatic conditions. Thus each year comes with lots of breeding time and as well as lots of pedigree for mosquitoes. Each pedigree of mosquito comes with lots of eggs, but unluckily mosquito population is adversely affected by climatic conditions of concerned geographical area and loose uniform population load. Instead of lab rearing it is unfeasible to detect their population load in an open field due to their large niche. So there is a need of an alternative way to detect their population load correctly. The malaria parasites are dependent on *Anopheles* mosquitoes for transmission between human hosts. [1] Human malaria infects up to 500 million people and results in almost 3 million deaths per year.[2] Control of the disease is currently limited to antiparasitic drugs and mosquito control.[3] So a detailed study was carried out to know whether malaria load demonstrate fluctuation round the year as per mosquito population load. Thus malaria cases can indicate mosquito population indirectly. Plasmodium enjoys uniform temperature in human body as primary host (eurythermal) other hand remaining part of parasitic life is spent in female anopheles mosquito as secondary host (poikilothermal). Poikilothermal anopheles mosquito population load is fluctuated adversely by climatic conditions resulting fluctuations in malaria load.

Material and methods

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Area of study

Bharatpur district from Rajasthan state was chosen as study area which lies in Aravalli foothills of Indian subcontinent. Bharatpur is situated between 26° 22' to 27° 83' North Latitude and 76° 53' to 78° 17' East Longitude. It is situated 100 meters above the sea level. It is 184 km. away from Delhi in South-East.

Data collection

Malaria cases from Bharatpur were collected for a year (Jun 2008-May 2009). On the basis of malaria cases mosquito population of *Anopheles* species was correlated in corresponding month to frame mosquito population rhythm. To validate the data malaria cases were retrieved from all towns of Bharatpur district for *Plasmodium viv*ex *and Plasmodium falciparum* pathogen. Only these two pathogens were found in malaria cases from Bharatpur. Malaria cases in table 1.1 & 1.2 and human population of Bharatpur District in table 1.3 were obtained from Office, CM & HO, Bharatpur, Rajasthan, India. Town wise population of Bharatpur district is obtained to link the feasibility with malaria cases. Whether report in table 1.4 was collected from India Meteorology Department, Rajasthan.

Table 1.1 *Plasmodium viv*ex cases in Bharatpur district

PLACE	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	Jan 09	Feb 09	Mar 09	Apr 09	May 09
Bharatpur city	6	8	24	36	1	4	0	2	2	0	9	7
Sewar	3	4	19	43	0	0	0	1	0	1	12	13
Kumher	6	9	84	69	10	2	0	0	0	1	7	12
Nadbai	5	7	48	57	1	0	0	0	0	1	1	19
Deeg	2	6	37	72	3	0	0	0	0	0	0	2
Nagar	9	6	13	50	1	0	3	0	0	1	0	5
Kama	0	1	4	6	0	0	0	0	0	0	1	2
Bayana	0	9	75	NA	NA	4	0	0	0	4	7	6
Bhusawar	4	24	90	77	22	0	0	0	1	2	14	36
Roopwas	19	31	210	351	101	4	3	4	1	4	24	43
Totalcases	54	105	604	761	139	33	6	7	4	14	74	145

Table 1.2 *Plasmodium falciparum* cases in Bharatpur district

Place	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	Jan 09	Feb 09	Mar 09	Apr 09	May 09
Bharatpur city	0	0	0	3	2	NA	3	0	0	0	0	0
Sewar	0	0	2	3	2	NA	1	0	0	0	0	0
Kumher	0	0	1	4	0	NA	0	0	0	0	0	0
Nadbai	0	0	3	4	0	NA	0	0	0	0	0	0
Deeg	0	2	0	0	0	NA	0	0	0	0	0	0
Nagar	0	1	0	0	0	NA	0	0	0	0	0	0
Kaman	0	1	0	2	0	1	0	0	0	0	0	0
Bayana	1	1	3	NA	NA	NA	1	0	0	0	1	0
Bhusawar	0	3	3	1	4	NA	0	0	0	1	0	0
Roopwas	0	2	13	3	0	NA	0	0	1	0	1	0
Total cases	**1**	**10**	**25**	**20**	**8**	**6**	**5**	**0**	**1**	**1**	**2**	**0**

NA: Not Available

Table 1.3 Population of Bharatpur District

PLACE	**Population in the year 2008**	**Population in the year 2009**
Bharatpur city	228826	233976
Sewar	231437	236644
Kumher	250615	256254
Nadbai	221569	226554
Deeg	245713	251242
Nagar	311617	318628
Kaman	267867	273894
Bayana	243828	249314
Bhusawar	236320	241637
Roopwas	256455	262225
Grand population of Bharatpur District	2494247	2550368

Table 1.4 Malaria status in Bharatpur district correlated with whether report

PLACE	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	Jan 09	Feb 09	Mar 09	Apr 09	May 09
P.vivex cases	54	105	604	761	139	33	6	7	4	14	74	145
P. falciparum cases	1	10	25	20	8	6	5	0	1	1	2	0
Total cases of Malaria	**55**	**115**	**629**	**781**	**147**	**39**	**11**	**7**	**5**	**15**	**76**	**145**
Rain fall (mm)	341.5	173.7	177.9	189.1	1.5	0.0	0.0	0.0	1.8	2.4	5.9	38.1
T_{max}	34.9	33.5	33.0	33.7	35.0	29.2	24.6	21.7	27.1	33.1	38.9	42.6
T_{min}	26.0	26.3	25.3	23.9	19.5	11.5	8.8	7.0	8.2	13.5	19.8	25.3
Relative Humidity	85	90	92	88	80	85	95	96	90	78	43	53

Results and discussion

Female mosquitoes of anopheles species are vector for malaria cases. Malaria cases are directly associated with mosquito population. Malaria case are found round the year in Indian subcontinent however, malaria load fluctuate greatly due to kinetic climatic conditions of the geographical area (table 1.4). Summers, rain, winter, spring are major seasons in Indian subcontinent. High rain fall derive optimum climatic conditions for mosquito population acceleration in raining season (July, August, and September). Simultaneously malaria cases are also increased evidenced with table 1.1 and 1.2. This increase is first time since monsoon rain fall so it is termed as **First log phase.** After first log phase winter arises in Indian subcontinent and turns down the optimum climate for mosquitoes in October, November, December, January, and February (table 1.4).This decline in mosquito population results in declined malaria cases (table 1.1 and 1.2) and may be termed as **First decline phase**. As per table 1.4 this decline is derived by cooling of environment (T_{min}) which halts optimum climatic conditions for mosquito. After winters spring begins in India (March, April, and May) and fetches optimum climate for mosquitoes, once again after raining season. As per table 1.4 increased minimum temperature and low rain fall conditions in spring derive optimum climatic conditions for mosquito population. Simultaneously malaria cases increase. Acceleration in mosquito population is being proposed as **Second log phase**. Statistically we find first log phase is much stronger than second log phase**.** Other hand it also gives an indication that climatic conditions of Second log phase are less favorable to mosquitoes than first log phase. Summer (June) halts optimum climate for mosquitoes and their population comes down. Simultaneously malaria cases also face decline once again (table1.1 & 1.2). This decline is a result of increased maximum temperature in summers in India. Human population of Bharatpur district (with towns) is given in table 1.3. This decline in mosquito population is termed as **Second decline phase.** Statistically we find second decline is not a big decline compared to first decline indicating comparatively higher mosquito population load in second decline phase than in first decline phase. Temperature of some areas in western India hikes so much in summers (around 47 degree centigrade) that it reduces mosquito population significantly and only those mosquitoes survive in such unfavorable climate which are capable to escape themselves around low temperature and humid areas e.g. nearby a shadow water source, air-cooler, bathrooms, shadow ditches, flowerpots, humid rooms, kitchen sink etc maintaining comparatively low temperature with humidity. These survivors also bring significant changes in their daily routine to avoid come in contact with high temperature.

Ultimately we can conclude more mosquitoes yield more malaria load while less mosquitoes yield less malaria load. This gives a direction to mosquito and malaria eradication program. Each year Indian government spends large money raised from tax payers to combat mosquitoes. Practically spray of larvicides is best result oriented eradication tool. It could be beneficial if larvicidal and mosquitocidal spray program could be initiated during first decline phase while mosquito population faces significant decline. It will greatly retard mosquito population and malaria cases in first log phase.

Thus we find annual mosquito population load in India shows a specialized rhythm in following order-

First log phase → **First decline phase** → **Second log phase** → **Second decline phase**

A schematic wave (not to scale) is displayed in fig.1.1 to express annual mosquito population rhythm. Climate change is responsible for fluctuation in malaria cases and mosquito population load.

Authors' contributions

Authors have equal contributions in the study and framing the manuscript.

Conflict of interest statements

We do not have any conflict of interest at any level.

Role of funding source and ethics committee approval

The study was fully self financed by the authors. All data displayed in paper was retrieved from government organizations and do not have any conflict of interest.

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