Seasonal Prevalence of Malaria Vectors (Diptera: Culicidae) in Southern Rajasthan

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Abstract:
The relative abundance of *Anopheline* species it's associated with different seasonal variables were conducted a study in Udaipur, Dungarpur and Banswara districts of province Rajasthan, India. *Anopheline* mosquitoes (n= 1113) were found during the period of July, 2018 to June, 2019. Total four *Anopheline* species were identified from different localities of three districts. Results revealed high relative abundance of *Anopheles culicifacies* (45.37%) followed by *Anopheles annularis* (27.85%), *Anopheles stephensi* (18.41%) and *Anopheles fluviatilis* (8.35%) respectively. The season wise highest abundance of *Anopheline* species was reported in the season of rainy (July to October) 38.09% and lowest in the season of winter (November to February) 29.29%. The climatic factors reveal that variations in temperatures, relative humidity and average rainfall in various seasons are mainly responsible for seasonal prevalence of *Anopeline* species in the study area. The results shown that the population dynamics of *Anopheline* vectors fluctuate with the change in geographic, demographic and climatic conditions. Results   of this study suggested that there is an urgent need for correct and effective mass surveillance and proper malaria control doing to be under taken in these sensitive areas.

Keywords: *Anopheline* species, seasonal abundance, malaria vectors.

INTRODUCTION

In spite of global efforts for its control, malaria is one of the most prevalent and destructive vector borne if transferable disease in the tropics. At present time the official statistics provide at the national vector borne disease control programme for malaria in India denote 0.7-1.6 million confirmed cases and 400-1000 deaths in a year NVBDCP (2018). In this time the major concerns in controlling malaria in India involving insecticides resistance in mosquitoes and increase in *Plasmodium falciparum* that are resistant to drugs it all the country (Dash *et al.*, 2008). Every where the world, mosquitoes belonging to genus *Anopheles* play an important role in communication of human malaria protozoa. Globally about 465 recognized *Anopheles* species complicated are noted of which about 70 have the potential to act as vectors for plasmodium (Marianne 2013; Sinka *et al.*, 2012; WHO, 2008). *Anopheles stephensi* is important reliable and responsible for malaria transmission in urban region in India (Senthil Kumar et al., 2013). In recent times, the occurrence of vector borne disease increased due to suitable environmental conditions main reason due to global warming, high relative humidity, uneven rainfall and public health facility all over the world (Kumar *et al.*, 2017a; Benelli, 2018).

The climatologically factors directly affect the qualitative and quantitative changes in mosquito breeding sites. Conditions such as rainfall, temperature are mainly responsible for seasonal variations. The environmental alterations may regulates adult mosquito populations and transmission from of different mosquito born disease including malaria (Bashar and Tuno, 2014; Wongkoon *et al.*, 2013).

MATERIAL AND METHODS

Study areas:
The districts of southern Rajasthan Udaipur, Dungarpur and Banswara in Rajasthan state, India were selected for the present study. These districts were selected on the basis of being intensive maize, wheat and rice, irrigation, areas, particularly malarial endemic and the favorable climatic conditions for mosquito breeding.

Dungarpur district is located between at 23°50'30''N latitude and 73°42'52.78'' E longitude and elevated at about 225 meter (738 feet) above the sea level. Dungarpur district lies in southern Rajasthan on the border with Gujarat. The district has an area of 3770 km² The district is roughly triangular in shape. The climate is subject to extreme variation with a hot season from April to June, monsoon from June to September and post monsoon from October to March. The average temperature ranges between 43°C (maximum) to 26°C (minimum), average relative humidity about 96% and 47cm to 76 cm of average rainfall.

Banswara district is located at 23.55°N, 74.45°E. It has an average elevation of (990 feet). Banswara district is southern Rajasthan with an area 5999 square km² located between 23.11° N to 23.56°N latitude and 73.58°E to 74.49°E. The maximum temperature rises up to 45°C to 46°C in summer season and minimum temperature fall in winter season up to 10°C to 20°C and normal annual rainfall is 82.59cm.

Udaipur is located at 24.525049°N- 73'677116°E. The city covers an area of 64 km² and lies at an altitude of 598.00 meter (1962 feet) above sea level. It is located in the southern Rajasthan in near the Gujarat border. The area of Udaipur district is 11724km² The district is characterized by hilly terrain with hills in the west and south, an elevated plateau in the north and plains in the north and plains in the east. In Udaipur, the average temperature is 24.2°C (75.7°F). The annual rainfall is 689mm. The humidity reaches to the extent of 90% during the month of monsoon.

Mosquito's collection and morphological identification
The entomological study of *Anopheline* species in these districts were directed to compile basic data. It was a detailed observation study of adult mosquito specimens were gathered from different localities of Udaipur, Dungarpur and Banswara districts. From July, 2018 to June, 2019 after approved acceptance of the villagers, by using suitable random sampling 10 villages were selected from different teshil of every district on the basis of already available data with reference to malaria endemicity and according to probability of work in these villages. Three seasons were selected for entire studies rainy, winter and summer. Mosquito collection was conducted out of three times in every season at each locality. *Anopheline* mosquitoes were collected every fort night in each month from human dwellings and cattle sheds from selected villages during the year. In every village seven human dwellings and four cattle sheds were selected for collection. For this intention resting mosquitoes on various sides were collected by using oral aspirator and light torch. Collected mosquitoes were transferred into plastic containers through a cut made on the side of the plastic containers. It was covered on its top with cloths netting and wrapped by rubber band. Mosquitoes were transported to Department of Zoology, University College of science, MLSU, Udaipur Rajasthan, for further identification.

Identification
The identification of the *Anopheline* species was identified with the help of pictorial identification key for Indian *Anopheline* published by NIMR, ICMR, New Dehli in 2007 and Nagpal and Sharma (1995).

After identification, *Anopheline* mosquito selected four further studies. Identification features were used and visualized to using stereoscopic microscope in the laboratory.

RESULTS

During the present entomological study a total of 1113 *Anopheline* mosquitoes were collected. These were varied up to the species level on the basis of their morphological characteristics. Total of 4 *Anopheline* species were identified from different localities from three districts. Results show overall high relative abundance of *Anopheles* Culicifacies (45.37%) followed by *Anopheles annularis* (27.85%), *Anopheles stephensi* (18.41%) and *Anopheles fluviatilis* (8.35%) respectively (Table 2).

**Seasonal wise prevalence of *Anopheline* species –**
The season wise relative abundance of *Anopheline* species was also defined the highest abundance of *Anopheline* species was reported in the season of rainy (38.09%) and lowest in the season of winter (29.29%). While lowest abundance in three districts were reported in the season of winter (25.06%), (32.79%) and (30.15%) in districts Udaipur, Dungarpur and Banswara respectively (Table 1).

Table 1: Seasonal prevalence of Malaria vectors in three geographical region of Southern Rajasthan (July, 2018- June, 2019).

District	Season								
	Malaria vectors	Rainy		Winter		Summer		Total	
		No.	% occurrence	No.	% occurrence	No.	% occurrence	No.	% Occurrence
Udaipur	*An. stephensi*	41	24.26	14	16.86	43	30.28	98	23.61
	An. Culicifacies	77	45.46	41	49.39	50	35.21	168	40.48
	An. annularis	48	28.4	28	33.73	37	26.05	113	27.22
	A. fluviatilis	3	1.77	21	25.30	12	8.45	36	8.67
	Total	**169**	**100**	**104**	**100**	**142**	**100**	**415**	**100**
Dungarpur	*An. stephensi*	24	15.00	5	3.49	17	12.78	46	10.55
	An. culicifacies	114	71.25	43	30.06	65	48.87	222	50.91
	An. annularis	19	11.87	71	49.65	41	30.82	131	30.04
	An. fluviatilis	3	1.87	24	16.78	10	7.51	37	8.48
	Total	**160**	**100**	**143**	**100**	**133**	**100**	**436**	**100**
Banswara	*An. stephensi*	25	26.31	8	10.36	28	31.81	61	23.38
	An. culicifacies	57	60.00	26	32.91	32	36.36	115	43.89
	An. annularis	11	11.57	34	43.03	21	23.86	66	25.19
	An. fluviatilis	2	2.10	11	13.92	7	7.95	20	7.63
	Total	**95**	**100**	**79**	**100**	**88**	**100**	**262**	**100**

Table 2: Distribution of Anopheline species in Southern Rajasthan

Anopheline species	Udaipur	Dungarpur	Banswara	Total
An. stephensi	98 (23.61)	46 (10.55)	61 (23.28)	205 (18.41)
An.culicifacies	168 (40.48)	222(50.91)	115(43.89)	505 (45.37)
An. anularis	113 (27.22)	131 (30.04)	66 (25.19)	310 (27.85)
An. fluviatities	36 (8.67)	37 (8.48)	20 (7.63)	93 (8.35)
Total	415 (37.28)	43(39.17)	262 (23.53)	1113
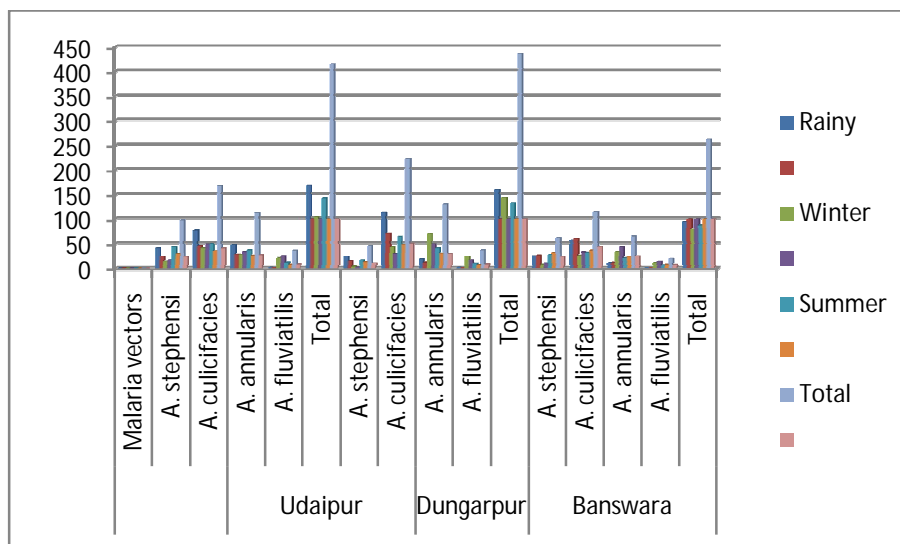
Graph 1: Seasonal prevalence of Malaria vectors in three geographic regions

DISCUSSION

The successful development of the malaria parasite in the mosquito depends largely on atmosphere. Higher temperature and higher humidity accelerate the parasite growth in mosquitoes. Total 1113 mosquitoes collected were belonging to genus *Anopheles* that is responsible for transmitting all species of *Plasmodium* in human. But in the present study were reported only 4 species as a whole from three districts. These include *Anopheles stephensi, Anopheles culicifacies, Anopheles annularis* and *Anopheles fluatilis* (Table 2). All these species belong to previously known *Anopheles* species in India. In furthermore to rainfall, temperature can also influence the presence of Anopheles species mosquitoes. The maximum temperature ranges from 25-27°C for mosquito breeding. During the first capture in February 2018, the outdoor temperature averaged less than 25°C, whilst in the second capture in June, 2018, the average temperature ranged from 26-27°C this permit mosquitoes to breed (Kemnkes *et al.,* 2013).

In present study, the perfect match of vector collections from indoor and outdoor places assisted to demonstrate our behavioral framework before and IRS treatments) also provided the efficiency of the vector, control interference and its effect on malaria transmission.

Although, *Anopheles culicifacies* and *Anopheles fluviatilis* are recorded to be primary vector of malaria in endemic districts of Odisha, *Anopheles culicifacies* was noted to the most abundant vector of human malaria in rural areas of Kalahandi during the study time. *Anopheles culicifacies* contributing to more than 60 % of the recorded malaria cases in India (Anvikar *et al.,* 2016).

The results of one another survey conducted in NWFP province of Pakistan regarding incidence of that they reported peak transmission of *Plasmodium falciparum* malaria that they reported peak transmission of *Plasmodium falciparum* in the month of October when *Anopheles culicifacies* was completely disappeared (Rowland *et al.,* 2002). The result of present study shows the affect of seasonal fluctuations of on the population dynamics of different *Anopheline* species. The variation of *Anopheles* population also affected the transmission of *falciparum* malaria in Udaipur, Dungarpur and Banswara. Meteorological data detect that variations in temperature, relative humidity and average rainfall in different months are most importantly responsible for prevalence of Anopheles mosquitoes (Graph 1). The reciprocal effect of temperatures, humidity and rainfall were shown in the seasonal richness of *Anopheline* species in our study. The highest prevalence of *Anopheline* mosquito was reported in the rainy season (Month of July followed by September) (Table 2). These results are

incompliance with the results of one study carried out in district Bhawalnagar, Punjab, Pakistan in reference to the ecology of adult *Anopheline* species.

They reported *Anopheles stephensi* and *Anopheles subpictus* as mainly prevalent species with highest prevalent species with highest prevalence of mosquitoes in the months of monsoon season (Herrel *et al.,* 2004). This shows that rainy season and early post monsoon seasons reported a favorable environment for the breeding of *Anopheline* mosquitoes.

CONCLUSION

The result of the study shown that the seasonal abundance of the malaria vectors were variables, being influenced by rainfall, temperature and humidity in this area.

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