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Species composition of adult anopheles populations in malaria prone region of Kolayat Tehsil, District Bikaner, Rajasthan, India

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Abstract
Background & Objective: The main objective of the study was to determine the abundance of vector mosquitoes varies with seasons. In this regard assessment of the composition, density and diversity of anopheline fauna in space and time can help to monitor the posibility of malaria in a region part from formulating the control strategies.
Method: The adult anopheles were collected over a period of two years by using aspirator as well as light traps torch while larval stages collected and rear in laboratories than identified as per using standard keys.
Result: A total of 1043 larval as well as adult specimens representing three Anopheline species viz: *Anopheles stephensi*, *An. subpictus* and *An. culicifacies* were observed from different breeding sites. The *An. subpictus* and *An. stephensi* were documented from all the studied area while *An. culicifacies* reported from two area. The density of *An. stephensi* and *An. subpictus* was dominant followed *An. culicifacies*. Low density were observed in all the studied area during summer month (March to June). Its peak value in month of Monsoon (August- September)
Conclusions: Result indicate that three anopheles species were involved in transmission of malaria in the region. *An. culicifacies* shows presence in the area is warning to workers of who are involved in malaria control programme.

Keywords: *Anopheles*, malaria

Introduction

Malaria is a major public health problem of India and one which contributes significant to the overall malaria burden in Southeast Asia. Malaria imposes great socio-economic burden on huminity. It has been reported to afflict 90 countries and territories in tropical and subtropical orgion.

The National vector borne disease control program of India reported 1.5 million case and 1100 death in 2009. As the second largest population country in the world; India's public health system faces many challanges including implementation of survellance programme to accurately estimate and control the national malaria burden (Das *et at.* 2008) [4].

There are 422 species of *Anopheles* world wide, many of them sibling species that can only be identified using genetic techniques. Of these, about 70 are malaria vectors but only 40 are important. There are six recognised primary vectors of malaria in India, viz. *Anopheles culicifacies. An. stephensi, An. dims, An. fluviatilis, An. minimus* and *An. sundaicus.* Vectors of secondary importance are *An. annularis, An varuna, An. jeyporiensis* and *An. philippinensis* (Rao, 1984) [9]. According to Sharma (1999) [12], *An. culicifacies* is the vector of rural and periurban malaria in peninsular India, *An. stephensi* is responsible for malaria in urban and industrial areas while, *An. fluviatilis* is the vector of local importance in forests and *An. minimus* in the foothills of North-Easthern states, while, *An. sundiacus* is restricted to Andman Nicobar islands.

District Bikaner is the situated in the north-western part of Rajasthan, is characterized by extremes of temperature is all seasons and low erratic rainfall. Bikaner district has very important and useful non-metallic minerals deposits in state. In district, the vast resources of lignite and gypsum; beside clay, fullers earth ochre and grift.

The study area Kolayat lies approximately 51 km away from Bikaner city headquarter. It is lying between 27º.27' and 28º23' north latitudes and 71º54' and 73º10' east longitudes and 230 meter above from sea level. Kolayat has a large sand dunes, which depicts beautiful natural scenaries. Kolayat is a part of Thar desert the plain is interspersed with shifting and hills, the slops of which are slightly furrowed by the action of wind. The presence of clay mines provide protection & shelters to adult anopheline fauna to breed properly and scattered brick industries provide preferred breeding sites to the mosquitoes here and there in the field. After introduction of Indira Gandhi canal in this tehsil the ecology of the area is altered and move favourable for vector to breed easily in the area. The Kolayat is famous for Holy dip in the lake in month of November for devotees, whereas it is also known to malaria prone area because last 10 years thousand of Pv and Pf malaria cases were reported. In the year 2007 1504Pv and 125 Pf and in year 2008 1683Pv and 69Pf malaria cases were positive in the area.

While in year 2010 total 544 Pv cases reported (According CMHO, Bikaner) hundred of malaria cases are common feature of this area. That's why present study were undertaken to update, knowledge of distribution and prevalence of vector species and assess their disease potential for the future.

Material & Methods

The present investigation carried out in four area of in vicinity of Kolayat tehsil. Periodic survey was undertaken August 2015 to July 2017; Mosquitoes and larval stages were collected with the help of suction tube and torch and dipping method for larval stages. Specimens were reared in laboratory and identified with using standard taxonomic keys as given by Roy & Brown (2003) [10].

Result

During the investigation the study was focussed only an adult anopheline fauna. Which may be potential carrier of malaria in the region.

Species Composition

During study the three anopheline species viz: *An. subpicuts*, *An. stephensi* and *An. culicifacies* were documented from Kolayat city. *An. stephensi* and *An. subpictus* were observed in all sampling site, whereas *An. culicifacies* was observed in two site in Table. 1.

In Kolayat city *An. stephensi* and *An. subpictus* were equally dominant species followed by *An. culicifacies*.

Species Density

(a) *An. subpicuts*

This species was documented from all the four study areas and was observed throughout the study period. In general, its density was be high during the months of July to October (16.50 to 37.00 pmh), declining thereafter and being low during the winter months of January-February (3.00 pmh) and again showing a rise trend as presented in Table 2 & Fig. 2. In Kolayat city, where four areas were marked for surveillance of mosquito species. In general, the density of this species during the year of survey was noted to be high in the month of September, highest being in vicinity of pond.

(b) *An. stephensi*

This species was also colleted from all four study areas. The species showed remarkable high trend of density in all four study areas throughout the year except the winter months January to March. The highest density was observed in the months of after rainy session (Table 3 & Fig. 3). The peak average density (24.62 pmh) was noted during the August.

(c) *An. culicifacies*

This species is a major vector of transmission the malaria diseases. In the last decad, this species was not earlier reported from the study area. Of the four sampling sites were surveyed, it was collected from only two sites viz., Kolayat and Gajner. The highest density (22.75 pmh) were reported in the month of August in Gajner followed by Kolayat (18.50 pmh). Lower densities (1 to 3.25 pmh) were found in January to June as presented in Table 4 & Fig 4.

Collection Sites

The anopheline species of mosquitoes during the present investigation were collected from the vicinity of various sites of the study area, which included puddles, Ponds, Cattle water point, Pipe leakages, construction sites Households, Fodder rooms and Cow sheds.

Table 1: Species composition of anopheline mosquitoes recorded from surveyed area and around Kolayat in year 2015-17.

Area	*Anopheles subpictus*	*Anopheles stephensi*	*Anopheles culicifacies*
Kolayat	++	+++	+
Kharicharanan	+	+++	NR
Kodamdesar	+	++	NR
Gajner	++	+++	++

NR: Not reported

+: 0+50; ++: 50 to 100; +++: >100.

Table 2: Monthwise density (No. per man hour) of mosquito *Anopheles subpictus* in and around Kolayat (August 15 to July 2017) [Values are monthly average data of year 2015-17]

Month	Kolayat	Kharicharanan	Kodamdesar	Gajner	Average density
August	28.00	16.50	**17.50**	24.25	30.87
September	37.00	16.00	16.00	23.00	23.00
October	27.00	14.50	17.00	24.50	20.75
November	21.00	11.00	16.25	19.25	16.87
December	10.50	10.00	11.25	10.25	10.50
January	3.00	5.00	6.00	7.50	5.37
February	3.00	4.00	5.50	4.75	4.31
March	7.50	6.25	5.00	4.50	5.81
April	9.50	7.00	6.00	6.00	7.12
May	6.25	5.50	6.50	6.00	6.06
June	8.00	6.50	7.00	7.25	7.18
July	16.50	9.50	8.25	9.75	11.00

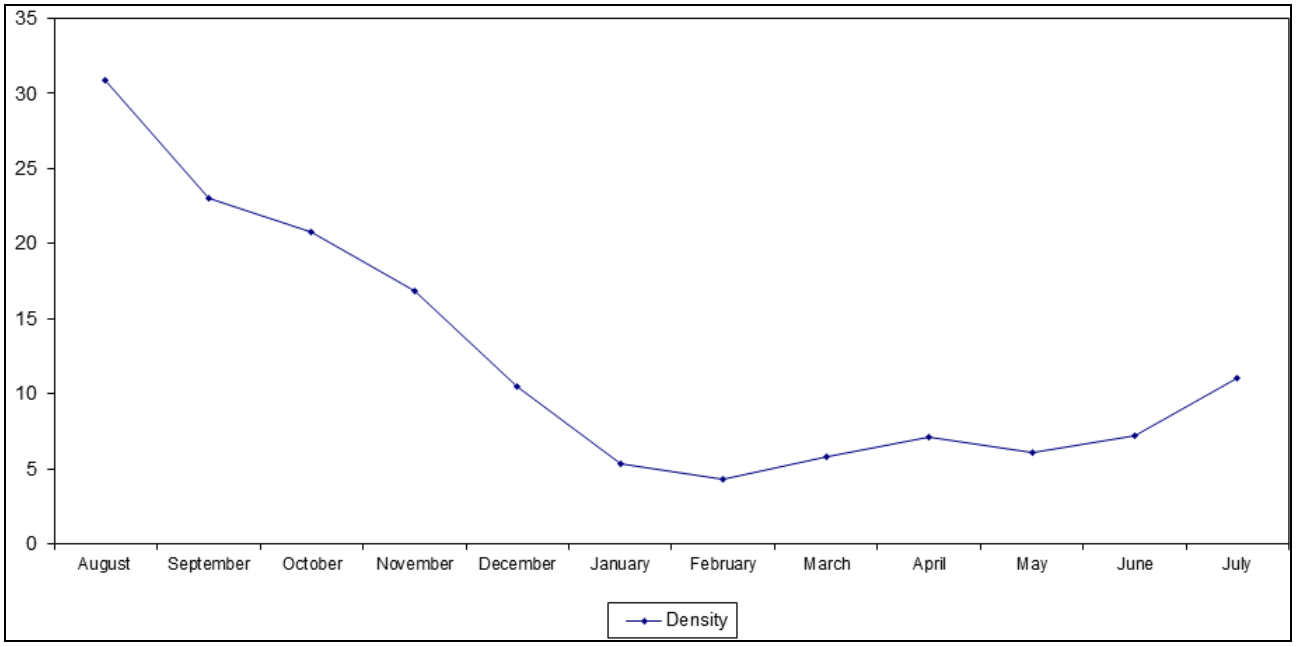

Fig 2: Monthwise density (No. per man hour) of mosquito *Anopheles subpictus* in and around Kolayat (August 15 to July 2017)

Table 3: Monthwise density (No. per man hour) of mosquito *Anopheles stephensi* in and around Kolayat (August 15 to July 2017) [Values are monthly average data of year 2015-17]

Month	Kolayat	Kharicharanan	Kodamdesar	Gajner	Average density
August	30.25	22.50	16.00	29.75	24.62
September	28.5	20.00	14.75	28.5	22.93
October	20.00	20.00	14.00	28.00	20.50
November	12.00	9.75	10.00	21.00	13.18
December	10.00	7.75	6.50	12.25	9.12
January	6.00	7.00	6.00	5.75	6.18
February	4.50	3.00	4.00	5.00	4.12
March	2.50	3.00	4.00	4.25	3.43
April	3.50	2.50	3.75	3.75	3.37
May	3.00	2.00	3.00	3.25	2.81
June	3.00	1.00	2.25	3.00	2.43
July	12.50	6.75	5.75	6.25	7.81

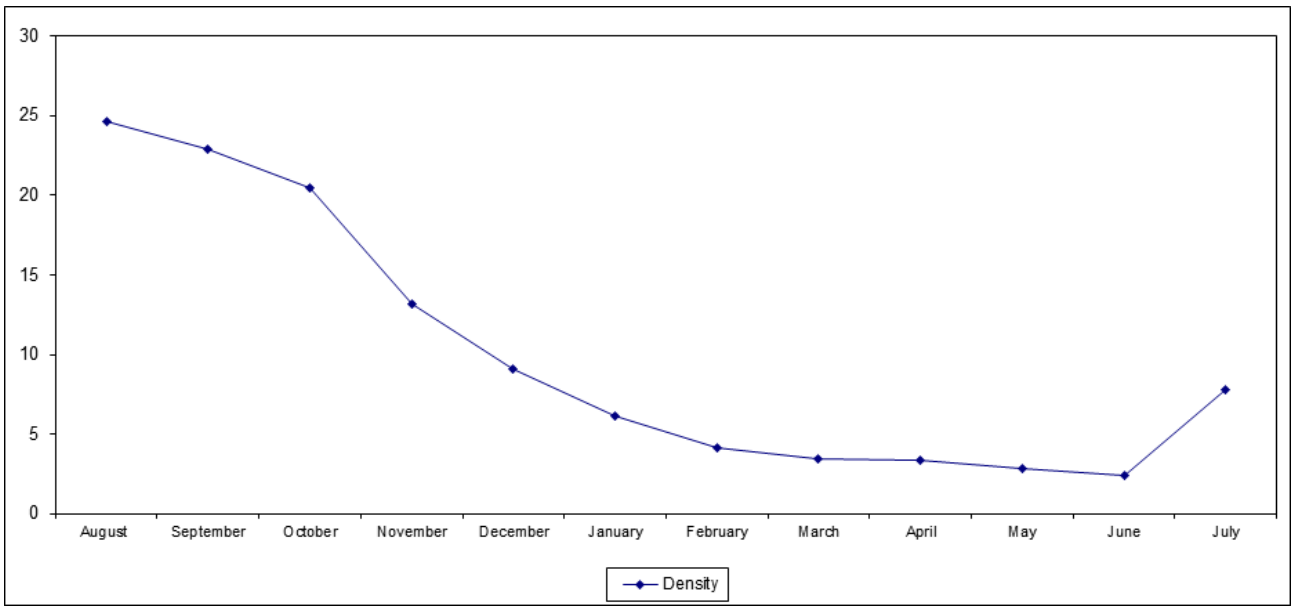

Fig 3: Monthwise density (No. per man hour) of mosquito *Anopheles stephensi* in and around Kolayat (August 15 to July 2017)

Table 4: Monthwise density (No. per man hour) of mosquito *Anopheles culicifacies* in and around Kolayat (August 15 to July 2017) [Values are monthly average data of year 2015-17]

Month	Kolayat	Kharicharanan	Kodamdesar	Gajner	Average Density
August	18.50	NR	NR	22.75	12.26
September	14.50	NR	NR	17.25	7.93
October	11.25	NR	NR	14.50	2.81
November	6.50	NR	NR	8.50	3.75
December	4.25	NR	NR	6.25	2.62
January	2.00	NR	NR	3.50	1.37
February	2.00	NR	NR	2.00	1.00
March	1.00	NR	NR	2.00	0.75
April	2.00	NR	NR	3.00	1.25
May	3.00	NR	NR	3.75	1.68
June	3.25	NR	NR	4.25	1.87
July	7.50	NR	NR	9.75	4.31

NR: Not reported

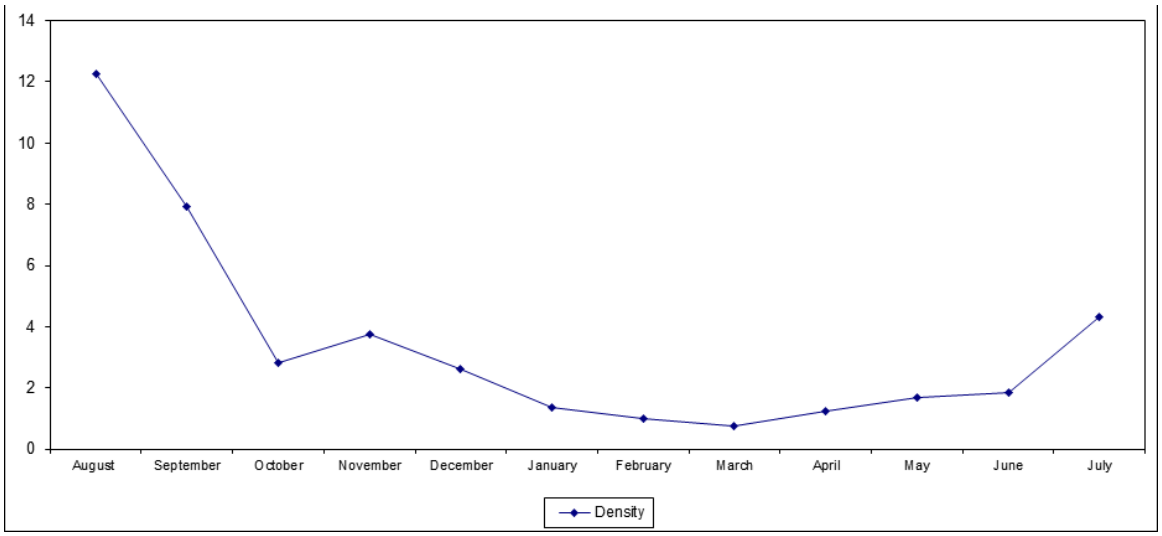

Fig 4: Monthwise density (No. per man hour) of mosquito *Anopheles culicifacies* in and around Kolayat (August 15 to July 2017)

Discussion

During the present study the anopheline species documented from Kolayat city were *An. subpictus*, *An. stephensi*, and *An. culicifacies*. The present findings are in conformation with the reports of Joshi *et al.* (2005) [6], Srivastava & Swami (2011) [15]. Who also documented *An. subpictus*, *An. stephensi*, *An. culicifacies* and *An. annularis* from the Thar desert area and Tyagi *et al.* (2001) [20] who recorded *An. stephensi*, *An. culicifacies*, *An. subpictus* and *An. annularis* from the Jaisalmer district of Rajasthan. Earlier according to Tyagi & Yadav (2001) [17], *An. stephensi*, *An. culicifacies* and *An. subpictus* were among the eight anopheline species acting as malaria vectors in north western Rajasthan, while Shukla *et al*. (1995) [13] suggested that malaria transmission in Rajasthan was caused by *An. stephensi*, *An. culicifacies* and *An. fluviatilis* in relays.

Tyagi & Choudhary (1997) [16] suggested that along with *An. stephensi*, the traditional malaria vector in xeric environment, *An. culicifacies* established itself in the areas extensively irrigated through canals. Till 1955 sixteen species were reported from Rajasthan (Puri, 1954) [8], most of them restricted to Udaipur zone in Southern Rajasthan while, only seven were recorded from five of the eleven desert districts (Christophers, (1933) [3]; Puri, 1936) [7], Bansal & Singh (1993) [1] since then added three more species viz., *An. nigrrimus* from Sri Ganganagar district, *An. d'thali* and *An. splendidus* from Jaisalmer raising the total to ten species. According to Tyagi (2004) [19], *An. stephensi* was responsible for transmitting malaria at low level in Rajasthan initially, but after initiation of canalized irrigation, several anophelines including *An. culicifacies* have established themselves in the region.

An. subpictus was documented from all the four study areas and, in general, the density of this species was noted to be high during August (30.87 pmh). The maximum density (37.00 pmh) of this species was noted in Kolayat during September, 2016. From around Kolayat the second highest density were observed in Kodamdesar & Gajner. The present finding get support of work of Srivastava & Swami (2011) [15], they suggested that the *An. subpictus* peak density was found in the month of August & September. The resident are engaged in farming and animal husbandary an area has local ponds and stagnant water.

An. stephensi was also collected from all four study areas although it showed different trend of density fluctuation during the period of study. Where density was very low (1.00 pmh). Very low density were observed in all the study area during the summer months (March to June). Its peak value

observed in Month of Monsoon.

The present finding get support from the work of Srivastava & Swami (2011) [15], who documented that the densities were decline after month of September and reached a minimum in the month of January and again showed increasing trands.

An. culicifacies was not reported from all the studied area. Both the species showed a different trend of densities. Lower population densities (range 0.00 pmh to 2.00 pmh) were observed in winter months. It is again get support of observation of Srivastava & Swami (2011) [15].

The peak adult density of *An. stephensi* and *An. culicifacies* were reported in the month of August by Sharma (1995) [11], while Shukla *et al.* (2007) [13] recorded the highest density of *An. culicifacies* during July to September in Uttranchal, supporting the present findings.

During the present study *An. stephensi* was the dominant species followed by *An. subpictus.* Tyagi *et al.* (2001) [20], Srivastava & Swami (2011) [15] reported *An. stephensi* to be the dominant species followed by *An. culicifacies, An. subpictus* and *An. annularis* from Jaisalmer district, supporting the present observation.

The present findings get support from the work of Herrel *et at.* (2004) [5] who documented that *An. stephensi* peaked in August month, which corroborate the present findings. Batra *et al.* (1999) [2] reported the density of *An. stephensi* to range between 2 to 14.58 pmh and of *An. culicifacies* between 0 to 0.9 pmh during summer season in Jodhpur district. According to Tyagi & Yadav (2001) [17] *An. stephensi* was the pre-dominant species in the un-irrigated areas of north western Rajasthan, the present study is supported by these findings.

Conclusion

Malaria eradication is the most essential work for the developing countries, including India, because 80% health budget is consumed in the control of malaria. The vector borne diseases are directly on indirectly associated with dynamics of vectors. Vector control is one of the essential component of any malarial eradication programme.

For the analysis of threating of vector borne disease, should be understand the preferred breeding site detail, conditions of survival of vectors, resting behaviour of vector. These some information may be helpful for implementation of any malaria control strategies.

Due to regular awareness programme conducted by PHC and volunteers about malaria, the malaria case in and around Kolayat significantly decreases. But presence of more serious vector like *An. culicifacies* in the two studied area once again warning in forth coming post monsoon period to the workers who are engaged in malaria eradication system.

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