



Original Research Article

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Vertical distribution of indoor resting adult *Phlebotomus* (*Euphlebotomus*) *argentipes* the vector of kala azar in Kala azar endemic foci of Bihar, India.

Chandrima Das^a, T.Mahapatra^b, M.P.Karthick^c, R.K.Das Gupta^d J.Nandi^e,
A.K.Mukhopadhyay^{f*}.

^aEntomological Surveillance Officer, Care India. ^b Head, MLE, Care India. ^c Manager. MLE Div. Care India, ^d Joint Director, National Vector Borne Disease Control Programme, Government of India, Delhi. ^e Ex Research Officer NVBDCP. Presently Consultant VL (Entomology), Care India. Bihar.

^f Ex Joint Director NCDC, Presently Consultant Care India, Bihar.

*Corresponding author: dramukhopadyay@gmail.com

Abstract

Since, 1976 to 2014, DDT, and from 2015 till date, alpha cypermethrin insecticide is being sprayed for two rounds per year as indoor residual spray up to 1.8 meter i.e 6 feet height in human dwellings as well as full cattle sheds in Bihar, India, as a part of Kala -azar elimination programme. This is being practiced due to the belief that in indoor resting *Phlebotomus argentipes* the vector of kala azar cannot hop beyond 6feet (1.8 meter) height. A study was therefore conducted between July to November 2016 in three villages of highly kala azar endemic block Warisnagar, district Samastipur of Bihar to understand whether the vertical distribution of indoor resting population of present day *P. argentipes* is the same or there is variation. During the entire study period it was noted that minimum 20.3 to maximum 59.6 percent (Median value 38) *P. argentipes* were found to rest beyond 6 feet (between 1.8 to 2.00s meter). Significant numbers (27.8%) of gravid and fully blood fed (5.4%) females were found to rest above 1.8meter (6ft) height. Therefore, full IRS coverage (beyond 1.8 meter), in human dwellings and cattle sheds may give good results in terms of human and sand fly contact as being done in malaria control programme in India.

Keywords: Vertical distribution, indoor resting population, *P. argentipes*, Bihar, India

Introduction

Visceral leishmaniasis or Kala-azar, one of the major Neglected Tropical Disease had apparently disappeared from India during 1960s due to collateral benefit of intensive Indoor Residual Spray (IRS) of DDT under National Malaria Control Programme in 1953 and subsequently

National Malaria Eradication Programme in 1958¹. But since 1970s, Bihar, Jharkhand, Uttar Pradesh and West Bengal are again under the grip of kala azar². As a part of vector control programme, since 1976 indoor residual spray of DDT at the rate of 1gm / sq. meter is being done

in human dwellings and cattle sheds up to 1.8 meter i.e 6 feet height for control of *Phlebotomus (Euphlebotomus) argentipes*, the proven vector of kala azar in India². In 1990, *P. argentipes* found to developed tolerance towards DDT in several parts of North Bihar³. Concerned with the increasing problem of VL in the country, the Government of India launched a centrally sponsored Kala-azar Control Programme in the endemic states in 1990 .National Health Policy-2002, set the goal of kala azar elimination in India by the year 2010 which was revised to 2015 at blocks/ PHC level^{4,5}. Now the target dates of elimination in 2017 Noting the wide spread DDT resistance problem in *P. argentipes*^{6,7,8}. Government of India along with Government of Bihar in the year 2015 has started vector control programme with two rounds of IRS with synthetic pyrethroid insecticide like alpha-cypermethrine at the dose of 25mgm per sq. meter twice a year up to 1.8 meter(6 feet) level of height with a belief that adult *P. argentipes* cannot hop beyond 1.8meter height ^{4 5}. But it is very important to know the recent behavioural changes of *P. argentipes* in endemic parts of Bihar the most kala azar prone state of India. Therefore, a study was conducted from July to November, 2016, in order to note vertical distribution of indoor resting population of present day *P. argentipes* in a highly kala azar endemic block Warisnagar, district Samastipur of Bihar.

Materials and Methods

Bihar state alone contributed more than 70 percent of total kala azar cases reported in the year 2011². In 2014 and 2015 the state contributed 82.4 percent and 76.6 percent kala azar cases respectively, in comparison to India (Dpt. of NVBDCP. Government of India). In Bihar, district Samastipur, (25° 5' N, 85° 5' E) contributed more than 8.5 percent Kala Azar cases of Bihar in 2014 & 2015 (Personal communication Dpt. NVBDCP. Government of Bihar). Two villages i.e. Satmalpur and Mannipur which are reporting perennial transmission of kala azar and are under insecticidal pressure for more than ten years and village Kishanpur is without any kala azar case and is not under indoor residual spray (IRS) for last five years were selected by random method for the study. All human dwellings and cattle

sheds of selected study villages were searched toughly by standard entomological methods. Rooms of those cattle sheds and human dwelling were showing typical atmosphere for sandfly breeding and evidence of sand flies were noted and marked. Out of marked houses, three human dwellings and three cattle sheds in each village were selected by random method. In each human dwelling and in each cattle shed, three CDC miniature light traps model 512, specially designed for sand fly collection (made by John W. Hock) were installed overnight (dusk to dawn) at the heights of 0.6 meter (2feet), 1.2 meter (4feet) and above 1.8 meter i.e between 1.8 to 2.00 meter (6feet) following standard WHO method ⁹. Light traps were installed from 15cm away from walls. In each village a total of eighteen light traps (nine each in human dwellings and cattle sheds) in different altitudes were installed. The installation of light traps were undertaken every third week of each month from July to November 2016. The sand flies, collected in individual trap were brought to the laboratory separately and height wise species identification has been done by the method of Lewis ¹⁰. Among all insects trapped in each light trap only adult male and female *P. argentipes* were considered for the present study. The stomach conditions of all female *P. argentipes* were noted as per standard WHO method ⁹.

Results and Discussion

Results on observation of vertical distribution of indoor population of *P. argentipes* in three study villages of block Warisnagar, district Samastipur from July to November 2016 are shown in Table 1 and Ttable 2. *P. argentipes* (both male and females) were collected month wise and village wise by light trap method as shown in Table 1. Village wise number of *P. argentipes* trapped up to the height of 0.6 meter (2feet), 1.2 meter (4feet) and between 1.8 to 2.0 meter (above 6feet) from July to November 2016 were noted . In village Satmalpur, minimum 9.5 percent in the month of November and maximum 39.2 percent in the month of August of *P. argentipes* were recorded up to 0.6 meter (2feet) height. Maximum of 56.6 percent (month of October) and minimum 19.6 percent (month of August) were noted above

Table 1: Denotes average numbers of adult *Phlebotomus argentipes* collected from different height from indoors in study villages of Block Warisnagar, District Samastipur, Bihar.

Month	SATMALPUR				MANNIPUR				KISHANPUR			
	Total no collected/height/night				Total no collected/height/night				Total no collected/height/night			
	Total	0.6 M (2 FEET)	1.2M (4FEET)	1.8 M (<6FEET)	Total	0.6M (2FEET)	1.2M (4FEET)	1.8M (<6FEET)	Total	0.6M (2FEET)	1.2M (4FEET)	1.8M (<6FEET)
Jun-16	82	29 35.3%	12 14.6%	41 50.0%	117	43 36.7%	41 35.0%	33 28.2%	359	109 30.3%	98 27.2%	152 42.3%
Jul-16	192	49 25.5%	48 25.0%	95 49.7%	239	86 35.9%	77 32.2%	76 31.7%	239	104 43.5%	56 23.4%	79 33.0%
Aug-16	469	184 39.2%	193 41.1%	92 19.6%	431	122 28.3%	191 44.3%	118 27.3%	174	57 32.7%	51 29.3%	66 37.9%
Sep-16	182	58 31.8%	53 29.1%	71 39.0%	135	51 37.7%	39 28.8%	45 33.3%	250	13 5.2%	88 35.2%	149 59.6%
Oct-16	180	47 26.1%	31 17.2%	102 56.6%	145	31 21.3%	67 46.2%	47 32.4%	103	42 40.7%	40 38.8%	21 20.3%
Nov-16	126	12 9.5%	65 51.5%	49 38.8%	15	2 13.3%	4 26.6%	8 53.3%	43	19 44.2%	10 23.3%	14 32.6%
Total	1231	379 30.7%	402 32.6%	450 36.5%	1082	335 30.9%	419 38.7%	327 30.2%	1168	344 29.4%	343 29.3%	481 41.1%

- Total 3 traps installed/ dwellings/ village/night

Table 2. Showing village wise, month wise and height wise distribution of male and female *Phlebotomus argentipes* along with their physiological conditions of district Samastipur in Bihar

Village Name	Month	0.6M (2 feet)					1.2 M (4 feet)					1.8 M (6 feet & above)				
		TM	Female				TM	Female				TM	Female			
	TF		UF	FF	G	TF		UF	FF	G	TF		UF	FF	G	
SATMALPUR	Jun	12	17	9	2	6	8	4	1	2	1	27	14	9	1	4
	Jul	24	25	16	6	3	31	17	10	3	4	49	46	36	1	9
	Aug	85	99	52	9	38	102	91	38	9	44	44	48	25	5	18
	Sep	49	9	8	0	1	47	6	6	0	0	61	10	8	0	2
	Oct	22	25	18	1	6	14	17	9	0	8	52	50	26	0	24
	Nov	7	5	4	0	1	40	25	20	0	5	29	20	19	0	1
	Total	199	189	107 56.6%	18 9.52%	55 29.1%	242	160	84 52.5%	14 8.7%	62 38.7%	262	180	123 68.3%	7 3.8%	58 32.2
MANNIPUR	Jun	21	22	6	3	13	16	25	11	4	10	18	15	14	0	1
	Jul	52	34	14	15	5	35	42	32	4	6	49	27	19	7	2
	Aug	70	52	20	3	29	100	91	47	10	34	79	39	30	5	4
	Sep	33	18	5	2	11	20	19	13	1	5	29	16	9	0	7
	Oct	15	16	11	1	4	30	37	25	1	11	17	30	17	0	13
	Nov	2	0	0	0	0	2	2	2	0	0	6	3	2	0	1
	Total	193	142	56 39.4%	24 16.9%	62 43.6%	203	216	130 60.1%	20 9.2%	66 30.5%	198	130	91 70%	12 9.2%	28 21.5%
KISHANPUR	Jun	39	70	48	6	16	38	60	46	4	10	61	91	72	8	11
	Jul	49	55	28	13	14	29	27	15	1	11	39	40	31	0	9
	Aug	32	25	14	0	11	31	20	10	2	8	44	22	15	1	6
	Sep	5	8	5	0	3	56	32	14	3	15	86	63	28	2	33
	Oct	17	25	12	0	13	19	21	15	1	5	8	13	7	0	6
	Nov	15	4	3	0	1	5	5	3	0	2	7	7	6	0	1
	Total	157	187	110 58.8%	19 10.1%	58 31.0%	178	165	103 62.4%	11 6.6%	51 30.9%	245	236	159 67.3%	11 4.6%	66 27.9%

Abbreviations: TF = Total female caught /night/trap/ month ; TM = Total male caught/night/trap/month; UF = Unfed female FF = Full fed female ; G = Gravid female.

1.8meter i.e between 1.8 to 2.0 meter height in the same village. In an average, out of a total 1231 flies collected from Satmalpur village, 450 i.e 36.5 percent were noted above 1.8 meter (6feet) height. Similarly minimum 27.3 percent flies (in the month of August) and maximum 53.3 percent *P.argentipes* (in the month of November) were collected above 1.8 meter in Mannipur village. Both the villages are endemic for kala azar transmission and are under IRS coverage. In the kala azar free unsprayed village Kishanpur, a minimum of 20.3 percent *P.argentipes* (in the month of October) and maximum of 69.6 percent (in the month of September) were collected between 1.8m to 2.0 meter height . Total density of *P.argentipes* in the three study villages, found between 1.2 meter and above1.8 meter height was found statistically significant with p value = 0.1552. Similarly, total density of *P.argentipes* between 0.6 meter and above 1.8 meter was also found statistically significant with p value = 0.1032 No significant difference in resting behaviours of adult *P.argentipes* were noted in cattle sheds and in human dwellings separately. Till now IRS (DDT or Alpha cypermethrin) insecticide being done up to 6 feet (1.8 meter) height with a believe that *P.argentipes* cannot hop above 6 feet (1.8 meter)^{1,2, 4, 5}. In our presents observation it has been revealed that in an average 36.5, 30.2 and 41.2 percent *P.argentipes* were trapped between 1.8 to 2.0 meter height in the villages Satmalpur, Mannipur and Kishanpur respectively between the months July and November 2016. Our present findings clearly show *P.argentipes* adults have changed their behaviour over the periods and significant numbers are available above 6 feet height ie between 1.8 to 2.0 meter (Table1). This warranted for change in policy of spray (*on the basis of findings*) by national programme

Table 2 shows the village wise, height wise and sex wise distribution of *P.argentipes* in the study period. Physiological conditions of female *P.argentipes* in different heights are also shown in Table 2. Physiological conditions of female flies are shown as nulliparous (NP), full blood fed (FF) and gravid (G) in the table. In village Satmalpur out of 442 *P.argentipes* collected above 1.8 m

height, 262 were male and 180 were females (with 2:1 male female ratio). Out of 180 females, 7 (3.8%), FF and 58 (32.2 percent) gravid were found to rest between 1.8 to 2.0 meter height. Similarly in Mannipur village, 328 flies were found above the above mentioned height, of which 198 were male and 130 were females. Out of 130 females 12 (9.2%) were full blood fed and 28 (21.5%) were gravid. Where as in Kishanpur village which is free from kala azar cases and without any IRS programme for last five years, a total 481 *P.argentipes* were trapped in Light trap between 1.8 to 2.0 meter height. Among them 248 were males and 236 were females with the ratio of approx. 1:1. Out of 236 females, 11 (4.6%) flies were full blood fed and 66 (27.9%) were in gravid condition. Out of the total female *P.argentipes* caught from the villages Satmalpur, Mannipur and Kishanpur, the number of gravid and fully blood fed female *P.argentipes* trapped between 1.8 to 2.0 meter height is statistically significant with p value 0.0084, 0.0241 and 0.0426 respectively.

With a belief that *P.argentipes* in India cannot hop beyond 1.8meter i.e 6 feet height^{1, 2, 4}. The IRS programme is going on accordingly up to the above mentioned height. But the present study clearly indicates that statistically significant number of *P.argentipes* (Blood fed and gravid) are also found beyond 1.8 meter (6 feet) height. Therefore, from our present observations it may be concluded that IRS should be carried out covering total height of the walls and cattle sheds to achieve the kala azar elimination target within the stipulated year.

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