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Studies on *Armigeres subalbatus* Mosquitoes in Tribal and Non-tribal Areas of Bankura District, West Bengal, India

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Abstract *Armigeres subalbatus* is known to be the vector of parasites for many human diseases like malaria, Japanese encephalitis, filariasis etc. Indoor-resting and man-landing collections were made for one year both from tribal and non-tribal areas of Bankura district, West Bengal, India. In tribal area indoor-resting collection of *Ar. subalbatus* in one year was only 18 (1.65% of the total catch) with man-hour density (MHD) of 0.38 and in non-tribal area the figure was 489 (14.82%) with MHD of 10.19. A total of 37 *Ar. subalbatus* (0.62% of total catch) with MHD of 0.06 were caught off man baits from indoor and outdoor locations in tribal area and the number was 3 177 (16.71%) in non-tribal areas with MHD of 5.52. Indoor-resting and man-landing collections were highest in October in tribal area and in April in non-tribal area. The maximum number of *Ar. subalbatus* came in contact with man in first and fourth quadrants of both day and night. No human parasite including filarial one was detected within this mosquito throughout the year long study period (August 2009 - July 2010) in both the areas.
Keywords *Armigeres subalbatus*; Tribal and non-tribal; Man-hour density; Man-landing rate

Introduction

Armigeres subalbatus is widespread in rural and urban areas of India. It comes to bite especially in the day and also at night (Das et al., 1971; Ghosh and Hati, 1980; Das et al., 1983). The biology of Ar. subalbatus was studied in Pondicherry (Bai et al., 1981) and in Singapore (Barr, 1964). It was observed in the laboratory that microfilariae of *Brugia malayi* and *Wuchereria bancrofti* were taken by *Ar. subalbatus* (Iyenger, 1938; Rajagopalan et al., 1977). In this mosquito species natural infection of *W. bancrofti* was found in India (Horsfall, 1955; Ghosh and Hati, 1966) and of *B. pahangi* was found in suburbia of Kuala Lumpur (Tan et al., 2011). Bankura district of West Bengal in India is known to be endemic for lymphatic filariasis caused by *W. bancrofti* (Rudra and Chandra, 2000; Chandra and Paramanik, 2008; Paramanik and Chandra, 2009).

Present study was performed to know the percentage, man-hour density (MHD) and seasonal variation of *Ar. subalbatus* in indoor-resting and man-landing collections in both tribal and non-tribal locations along with man-landing rates in a comparative basis with a view to gather information on the biological behavior of this mosquito. The capability of carrying any human parasite by the natural population of this mosquito was also observed.

1 Result

During indoor-resting collection, out of 1 088 mosquitoes of 7 species in tribal area and 5 279 mosquitoes of 10 species in non-tribal area, *Ar. subalbatus* was 18 (1.65%) and 489 (14.82%) respectively as shown in Table 1. Average MHD of *Ar. subalbatus* was 0.38 in tribal area and 10.19 in non-tribal area among other mosquito species (Figure 1). The highest number (5) of *Ar. subalbatus* was collected in October in tribal area and it was (52) in April in non-tribal area (Table 2). Season wise analysis showed that, in rainy, winter and summer seasons number of indoor resting *Ar. subalbatus* were 5 (27.78%), 6 (33.33%) and 7 (38.89%) respectively in tribal areas and 172 (35.17%), 180 (36.81%) and 137 (28.02%) respectively in non-tribal areas (Figure 2).

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Table 1 Number and percent of different species of indoor-resting mosquitoes collected during August 2009 to July 2010 in tribal and non-tribal areas of Bankura district, West Bengal, India

Species	Tribal		Non-tribal		Total	
	No.	%	No.	%	No.	%
1. *Armigeres subalbatus*	18	1.65	489	14.82	507	11.56
2. *Anopheles annularis*	0	0.00	4	0.12	4	0.09
3. *Anopheles barbirostris*	84	7.72	38	1.15	122	2.78
4. *Anopheles subpictus*	28	2.57	24	0.73	52	1.19
5. *Anopheles vagus*	258	23.71	186	5.64	444	10.12
6. *Culex quinquefasciatus*	476	43.75	2184	66.20	2660	60.63
7. *Culex vishnui* group	220	20.22	276	8.37	496	11.31
8. *Mansonia indiana*	4	0.37	36	1.09	40	0.91
9. *Stegomyia aegypti*	0	0.00	54	1.64	54	1.23
10. *Stegomyia albopictus*	0	0.00	8	0.24	8	0.18
Total	1088	100.00	3299	100.00	4387	100.00

Table 2 Month wise number, percent and man-hour density of indoor-resting *Ar. subalbatus* during August 2009 to July 2010 in tribal and non-tribal areas of Bankura district, West Bengal, India

Month	Tribal			Non-tribal		
	No.	%	Man-hour density	No.	%	Man-hour density
August	0	0.00	0.00	47	9.61	11.75
September	0	0.00	0.00	35	7.16	8.75
October	5	27.78	1.25	45	9.20	11.25
November	2	11.11	0.50	42	8.59	10.50
December	4	22.22	1.00	43	8.79	10.75
January	0	0.00	0.00	44	9.00	11.00
February	0	0.00	0.00	51	10.43	12.75
March	4	22.22	1.00	45	9.20	11.25
April	3	16.67	0.75	52	10.63	13.00
May	0	0.00	0.00	24	4.91	6.00
June	0	0.00	0.00	16	3.27	4.00
July	0	0.00	0.00	45	9.20	11.25
Total / Average *	18	100.00	0.38 *	489	100.00	10.19 *

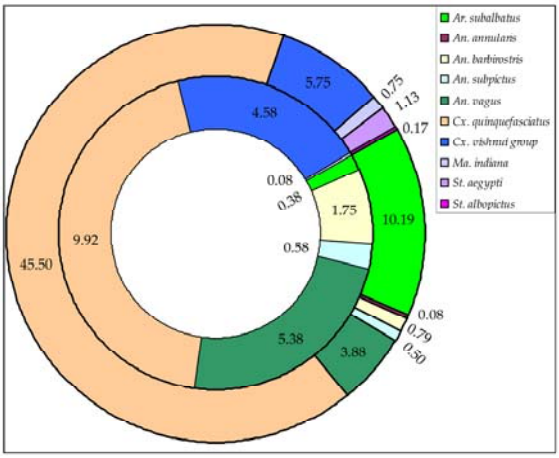

Figure 1 Man-hour density of different indoor-resting species of mosquitoes in tribal (inner-tire) and non-tribal (outer-tire) areas

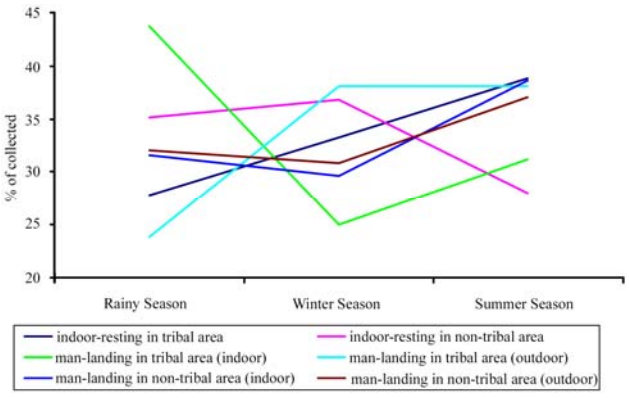

Figure 2 Variation of *Ar. subalbatus* collected in different seasons

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Table 3 Number and percent of different species of man-landing (indoor and outdoor together) mosquitoes collected during August 2009 to July 2010 in tribal and non-tribal areas of Bankura district, West Bengal, India

Species	Tribal						Non-tribal					
	Day-biting		Night-biting		Total		Day-biting		Night-biting		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1. *Ar. subalbatus*	32	4.71	5	0.09	37	0.62	2617	69.29	560	3.67	3177	16.71
2. *An. annularis*	0	0.00	0	0.00	0	0.00	0	0.00	8	0.05	8	0.04
3. *An. barbirostris*	0	0.00	161	3.03	161	2.69	0	0.00	125	0.82	125	0.66
4. *An. subpictus*	39	5.74	163	3.07	202	3.37	20	0.53	139	0.91	159	0.84
5. *An. vagus*	179	26.32	1200	22.60	1379	23.03	97	2.57	1168	7.66	1265	6.65
6.*Cx.quinquefasciatus*	209	30.74	2144	40.38	2353	39.29	635	16.81	11739	77.02	12374	65.06
7. *Cx.vishnui* group	221	32.50	1628	30.66	1849	30.87	97	2.57	1278	8.39	1375	7.23
8. *Ma. indiana*	0	0.00	8	0.15	8	0.13	0	0.00	147	0.96	147	0.77
9. *St. aegypti*	0	0.00	0	0.00	0	0.00	244	6.46	63	0.41	307	1.61
10. *St. albopictus*	0	0.00	0	0.00	0	0.00	67	1.77	14	0.09	81	0.43
Total	680	100.00	5309	100.00	5989	100.00	3777	100.00	15241	100.00	19018	100.00

Table 4 Month wise number, percent and man-hour density of 24 hour man-landing *Ar. subalbatus* during August 2009 to July 2010 in tribal and non-tribal areas of Bankura district, West Bengal, India

Month	Tribal							Non-tribal						
	Indoor		Outdoor		Total		Man-hour density	Indoor		Outdoor		Total		Man-hour density
	No.	%	No.	%	No.	%		No.	%	No.	%	No.	%	
August	2	12.50	0	0.00	2	5.41	0.04	104	8.37	164	8.48	268	8.44	5.58
September	0	0.00	1	4.76	1	2.70	0.02	88	7.09	144	7.44	232	7.30	4.83
October	3	18.75	4	19.05	7	18.92	0.15	99	7.97	151	7.80	250	7.87	5.21
November	1	6.25	4	19.05	5	13.51	0.10	85	6.84	139	7.18	224	7.05	4.67
December	3	18.75	2	9.52	5	13.51	0.10	104	8.37	156	8.06	260	8.18	5.42
January	0	0.00	1	4.76	1	2.70	0.02	83	6.68	147	7.60	230	7.24	4.79
February	0	0.00	1	4.76	1	2.70	0.02	97	7.81	155	8.01	252	7.93	5.25
March	5	31.25	1	4.76	6	16.22	0.13	125	10.06	183	9.46	308	9.69	6.42
April	0	0.00	5	23.81	5	13.51	0.10	128	10.31	189	9.77	317	9.98	6.60
May	0	0.00	2	9.52	2	5.41	0.04	115	9.26	178	9.20	293	9.22	6.10
June	0	0.00	0	0.00	0	0.00	0.00	112	9.02	168	8.68	280	8.81	5.83
July	2	12.50	0	0.00	2	5.41	0.04	102	8.21	161	8.32	263	8.28	5.48
Total / Average*	16	100.00	21	100.00	37	100.00	0.06 *	1242	100.00	1935	100.00	3177	100.00	5.52 *

During man-landing collection, out of 5 989 mosquitoes of 7 species in tribal area and 19 018 mosquitoes of 10 species in non-tribal area, *Ar. subalbatus* was 37 (0.62%) and 3 177 (16.71%) respectively as shown in Table 3. The highest number (5) was collected indoors in March and outdoors (5) in April in tribal study area. In non-tribal area the highest numbers (128 and 189) were collected at indoors and outdoors both in April. Average MHD of man-landing mosquitoes was 0.06 and 5.52 in tribal and non-tribal locations respectively (Table 4). In tribal area 12 (32.43%), 12 (32.43%) and 13 (35.14%) man-landing *Ar. subalbatus* were collected during rainy, winter and summer seasons respectively and in non-tribal area the corresponding figures were 1 013 (31.89%), 966 (30.41%) and 1 198 (37.71%) respectively (Figure 2). Out of 24 hour man-landing collection, day-biting *Ar. subalbatus* was 32 (4.71%) out of 680 (including indoors and outdoors) and 2 617 (69.29%) out of 3 777 different mosquitoes in tribal and non-tribal areas respectively, whereas corresponding figures for night-biting *Ar. subalbatus* was 5 (0.09%) out of 5 309 and 560 (3.67%) out of 15 241 respectively (Table 3).

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Table 5 Hour wise number and percent of day-biting *Ar. subalbatus* during August 2009 to July 2010 in tribal and non-tribal areas of Bankura district, West Bengal, India

Hours	Tribal						Non-tribal					
	Indoor		Outdoor		Total		Indoor		Outdoor		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0600~0700	3	21.43	3	16.67	6	18.75	77	7.51	187	11.75	264	10.09
0700~0800	1	7.14	2	11.11	3	9.38	68	6.63	86	5.40	154	5.88
0800~0900	1	7.14	1	5.56	2	6.25	72	7.02	79	4.96	151	5.77
0900~1000	1	7.14	1	5.56	2	6.25	60	5.85	45	2.83	105	4.01
1 000~1100	0	0.00	0	0.00	0	0.00	40	3.90	43	2.70	83	3.17
1100~1200	0	0.00	0	0.00	0	0.00	46	4.49	24	1.51	70	2.67
1200~1300	0	0.00	0	0.00	0	0.00	39	3.80	28	1.76	67	2.56
1300~1400	0	0.00	0	0.00	0	0.00	37	3.61	47	2.95	84	3.21
1400~1500	0	0.00	0	0.00	0	0.00	61	5.95	76	4.77	137	5.24
1500~1600	1	7.14	2	11.11	3	9.38	75	7.32	113	7.10	188	7.18
1600~1700	2	14.29	3	16.67	5	15.63	185	18.05	180	11.31	365	13.95
1700~1800	5	35.71	6	33.33	11	34.38	265	25.85	684	42.96	949	36.26
Total	14	100.00	18	100.00	32	100.00	1025	100.00	1592	100.00	2617	100.00

Table 6 Hour wise number and percent of night-biting *Ar. subalbatus* during August 2009 to July 2010 in tribal and non-tribal areas of Bankura district, West Bengal, India

Hours	Tribal						Non-tribal					
	Indoor		Outdoor		Total		Indoor		Outdoor		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1800~1900	1	50.00	0	0.00	1	20.00	47	21.66	63	18.37	110	19.64
1900~2000	0	0.00	1	33.33	1	20.00	31	14.29	42	12.24	73	13.04
2000~2100	0	0.00	0	0.00	0	0.00	23	10.60	32	9.33	55	9.82
2100~2200	0	0.00	0	0.00	0	0.00	11	5.07	19	5.54	30	5.36
2200~2300	0	0.00	0	0.00	0	0.00	12	5.53	24	7.00	36	6.43
2300~2400	0	0.00	0	0.00	0	0.00	9	4.15	19	5.54	28	5.00
0000~0100	0	0.00	0	0.00	0	0.00	8	3.69	18	5.25	26	4.64
0100~0200	0	0.00	0	0.00	0	0.00	6	2.76	16	4.66	22	3.93
0200~0300	0	0.00	0	0.00	0	0.00	10	4.61	19	5.54	29	5.18
0300~0400	0	0.00	1	33.33	1	20.00	11	5.07	22	6.41	33	5.89
0400~0500	1	50.00	0	0.00	1	20.00	18	8.29	27	7.87	45	8.04
0500~0600	0	0.00	1	33.33	1	20.00	31	14.29	42	12.24	73	13.04
Total	2	100.00	3	100.00	5	100.00	217	100.00	343	100.00	560	100.00

When the day (0600hrs to 1800hrs) was divided into 4 quadrants, the maximum numbers of *Ar. subalbatus* were caught in the last quadrant (59.38% in tribal area and 57.39% in non-tribal area), whereas in 1st, 2nd and 3rd quadrants, only 34.38%, 6.25% and 0.0% mosquitoes were caught in tribal area and 21.74%, 9.86% and 11.0% in non-tribal area (Table 5). During night (1800hrs to 0600hrs) the figures in 1st, 2nd, 3rd and 4th quadrants were 40.0%, 0.0%, 0.0% and 60.0% respectively in tribal area and 42.50%, 16.79%, 13.75% and 26.96% respectively in non-tribal area (Table 6). The biting peak of *Ar. subalbatus* was 34.38% and 36.26% in tribal and non-tribal areas respectively in between 1700hrs and 1800hrs. Comparing the man-landing collection of 24 hour from all the micro-habitats, highest biting activity of *Ar. subalbatus* was found during 4th quadrants of day time (Figure 3).

There was no incidence of any kind of human parasite

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within indoor-resting and man-landing Ar. subalbatus in tribal and non-tribal study areas.

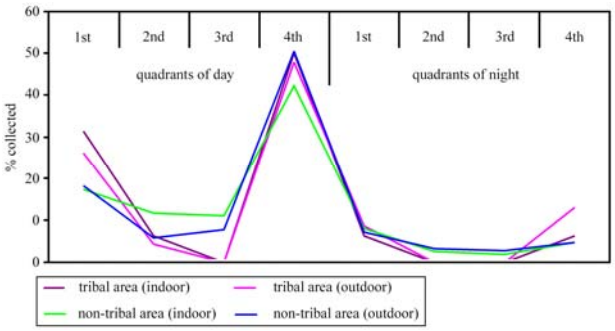

Figure 3 Frequency of man-biting *Ar. subalbatus* in different quadrants of day and night

2 Discussions

In the present study areas indoor resting *Ar. subalbatus* was not the dominant mosquito species, matching some other studies (Chandra, 1998; Chandra et al., 2007; Paramanik and Chandra, 2010) but unlike of some studies also (Das et al., 2003; Amala and Anuradha, 2011).

The total number of *Ar. subalbatus* collected from indoor-resting and man-landing conditions in tribal areas was significantly lower than those of non-tribal areas of the same district ($p < 0.05$). Suitable water bodies available for mosquito breeding in many areas of Bankura, often polluted and closely located with human habitations (Paramanik and Chandra, 2012). The non-tribal shelters, situated near open drains blocked with garbage and polluted bodies around, were more congested with furniture, clothings and other household materials. On the other hand, the tribal areas were situated within the forest areas. Sanitary structures like sanitary latrines, stagnant drains, cesspits, cesspools, cow dung gas plants etc. were totally absent in this nature bound low-populated tribal areas. The tribal shelters along with the surroundings were clean enough due to their socio-cultural background which does not make the tribal area conducive for breeding of *Ar. subalbatus*. Prevalence of higher number of this species in thickly populated non-tribal areas i.e. towns, semi-towns indicates maximum water pollution in comparison to natural tribal areas. Ill developed sanitary structures and unplanned urbanization in towns and semi-towns of non-tribal areas favouring to build up mosquitogenic sites especially for *Ar. subalbatus* and *Culex quinquefasciatus* due to heavy organic pollution. Whereas in tribal area, the nature controls the microenvironment and hence the surroundings are less affected by the man-made pollution. As a result the number of this pollution index mosquito, *Ar. subalbatus* was very few along with lower prevalence of *Cx. quinquefasciatus*, filarial vector, causing lesser filarial problem in these tribal areas of Bankura district, West Bengal (Rudra and Chandra, 1998, 2000). No significant seasonal variation was observed in both indoor-resting and man-landing collections in both the study areas ($p > 0.05$).

From 24 hour man-landing collections in non-tribal areas, it was found that this species was mostly active during the day. Among the other mosquitoes attacking man, *Cx. quinquefasciatus* occupied the second place. As a greater number of *Ar. subalbatus* were recovered from outdoor baits, it can be presumed that this species is exophagous in nature. Peak man-landing hour was observed at dusk between 1700hrs and 1800hrs in both study areas as also reported by Das et al (1983). The other biting peak was noticed between 1800hrs and 1900hrs after which the biting activity decreased and increased again at dawn hours.

Though different parasitic infections like *Plasmodium gallinaceum* (Roy and Brown, 1970), Japanese Encephalitis virus (Chen et al., 2000) and filarial parasite *Brugia pahangi* (Edson et al., 1960) have been reported in *Ar. subalbatus* from different parts of the world, no human parasitic infection was available in this mosquito species in the current study areas.

3 Materials and Methods

The tribal study areas were situated within dense or moderate forests, completely isolated from towns and semi-towns of non-tribal areas of Bankura District, West Bengal. According to data available from local meteorological department, during the study period (from August 2009 to July 2010), average temperature ranged from 17.87°C to 33.67°C, humidity from 39.65% to 84.42% and rainfall from 0.00 mm to 235.3 mm in different months. One spot each in 8 tribal

villages and one spot in each of 8 non-tribal areas were selected for collection of mosquitoes. Ten human habitations were fixed in each spot of both tribal and non-tribal areas and indoor-resting mosquitoes were captured between 0600hrs and 0800hrs for 12 minutes from each habitation once in a week alternatively from a tribal spot and a non-tribal spot following the method of WHO (1975) and De and Chandra (1994). Thus, in one year, a total of 48 man-hours were employed each in tribal and non-tribal areas.

Man-landing mosquitoes were collected from man-baits (human volunteers) from both indoors and outdoors spending 24 hours in a day (from 0600hrs of a day to 0600hrs of the following day) twice in a month throughout the year from tribal and non-tribal areas (in alternative week) following the method of Service (1976) and Chandra and Hati (1993). So, 576 man-hours were employed in each location of indoor and outdoor in each area.

Indoor-resting and man-landing mosquitoes were identified (Christophers, 1933; Barraud, 1934; Hati, 1979; Harbach, 1988) and dissected to detect any kind of parasitic infection. Chi-square test (to compare proportions), standard normal deviate 'Z' test (to compare rates) and Student's 't' test (to compare averages) were used for statistical analyses of the available data (Zer, 1999).

Authors' Contribution

G. Chandra designed the work and supervised overall and checked the manuscript. S.K Rudra and M. Paramanik have done the full work and wrote the manuscript with statistical analysis.

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