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Indoor resting density pattern of mosquito species in Fingeswar block of Raipur district in Chhattisgarh, central India

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Abstract Anopheline mosquitoes are vectors of human malaria and hence they are of greatest concern. Around 40% of the world's population resides in malaria affected areas. Malaria affects poor communities and causes enormous economic losses. The deadly disease annually causes clinical illness in 400–600 million people and kills 2–3 millions annually (WHO 2008). Faunistic survey was conducted in Fingeswar block in Raipur district of Chhattisgarh state of India during January 2003 to March 2004 to asses the prevalence of different species of mosquitoes and their seasonal variations.

Indoor resting mosquitoes were collected from selected houses in 5 villages using aspirator tube and torch light in the morning between 06:00–08:00. Adult mosquitoes were identified using standard morphological and pictorial keys following Rao (1984), Das et al. (1991) and Reuben et al. (1994) and assessed as person hour density.

A total of 13,248 mosquitoes were collected during the study period. Nine species of mosquitoes comprising of 4 genera with 5 *Anopheles*, two *Culex* and one each *Armigeres* and *Aedes* were recorded. The malaria vectors constituted 14.09% of the total mosquito collections. *Anopheles subpictus* (25.81%) showed the dominance followed by *A. annularis* (8.68%), *A. barbirostris* (6.76%), *A. culicifacies* (5.41%) and *A. pallidus* (4.11%). The other genus recorded included *Culex quinquefasciatus* (38.38%), *C. vishnui* (3.32%), *Armigeres subalbatus* (6.92%) and *Aedes albopictus* (0.29%). The density of all the species were high in months of August, September and October, decreased in month of May and June 2003. There was a significant ($p < 0.01$) positive correlation between temperature and density of *A. culicifacies* and *A. annularis*. The seasonal distribution pattern of *A. culicifacies* (primary) and *A. annularis* (secondary) malaria vectors along with other mosquito species was studied which is an important component of epidemiological study of malaria. This information will help in formulating a baseline structure for control program in the study region.

Keywords Prevalence, Vector, *Anopheles*, Seasonal variation, Indoor resting

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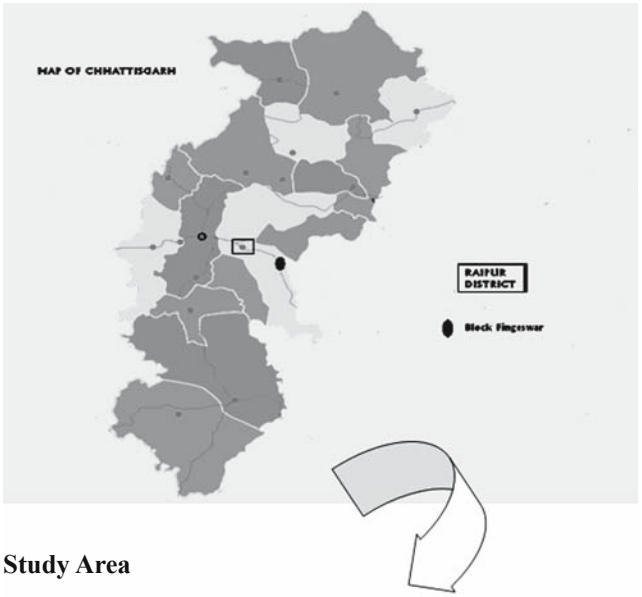
Introduction

Malaria is recognized as one of the major health problem by WHO (1990). The disease is caused by 4 different protozoan species of genus *Plasmodium* and is transmitted by anopheline group of mosquitoes. In India anopheline fauna comprises of 58 mosquito species of them 6 species can transmit malaria in different geographical region. Several reports regarding the distribution of mosquito vectors in relation to climatic condition in different parts of the country

are available (Bhattacharya et al. 2006; MRC 2002; Sharma 1998). *Anopheles culicifacies* and *Anopheles stephensi* are reported as vector in rural and urban areas, respectively (Batra et al. 2001). Prakash and Husainy (1974) for the first time surveyed and reported *Anopheles* mosquitoes in Bastar district of Chhattisgarh. Further, Husainy (1986) studied bionomics of *A. annularis* primarily resting in the cattle sheds. Kulkarni (1990) reported 17 anopheline species in indoor and outdoor collections of highly malarias areas of Bastar district. Husainy (1981) described culicine mosquito from Bastar district and latter the seasonal dynamics of *Culex. quinquefasciatus* in Raipur city of Chhattisgarh state was studied by Dixit et al. (2002). Kulkarni and Rajput (1988) at field Operation Research Station, Jagdalpur, recorded 48 species of culicine mosquitoes in old Bastar district of Chhattisgarh. Saxena et al. (1992) made critical appraisal of entomological data in five cities viz, Bhopal, Bilaspur, Gwalior, Indore and Raipur of Madhya Pradesh in relation to malaria epidemiology. Singh et al. (1999, 2004) have studied the population dynamics of *A. culicifacies*, the principal vector of malaria in central India. Baghel et al. (2008) reported resting density of different mosquito species in Chhura block of Raipur district. Vector control is an essential component of any malaria control program, the success of which relies on knowledge of vector species present in area and their bionomics. Mosquito blood meal identification is an integral part of most arthropod transmitted disease investigations. The feeding preference of mosquitoes on humans is an important element in their vectorial capacity and role in transmission of vector borne diseases (Dye and Hasibeder 1987). However, very limited and scattered information is available regarding the distribution of mosquito species in Fingeswar area of Raipur district of Chhattisgarh state, so the present study was undertaken.



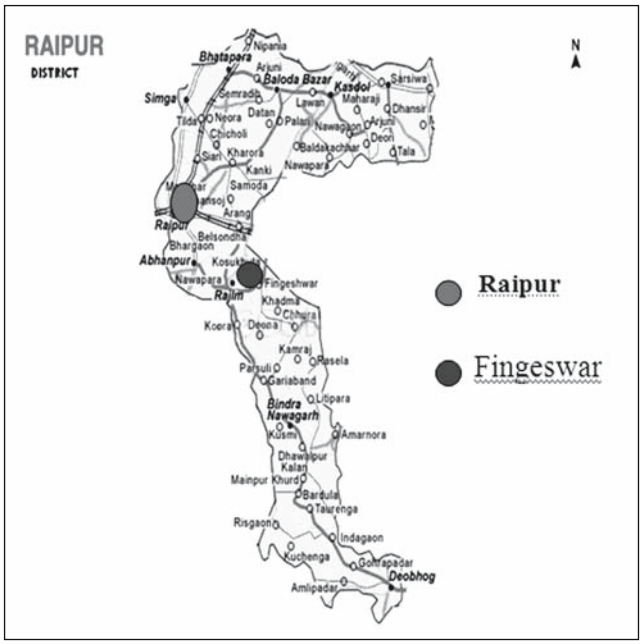


Fig. 1 Location of block Fingeswar in Raipur district of Chhattisgarh

Material and methods

Study region

The study was conducted in Fingeswar block of Raipur district in Chhattisgarh state. Raipur district forms the south-east part of Chhattisgarh and lies between 19° 57' and 21° 55' north latitudes and 81° 25' east and 83°38' east longitudes. The state and the district are bounded by Orissa which has the highest malaria incidence in the country. Fingeswar is one of the important blocks of Raipur district located 290 meter above sea level. Twenty-six percent area of the block is covered with forest and it is inhabited predominantly by tribal population. Five villages randomly selected for the present study included, Borid, Borsi on the eastern side; Roba and Sendar on the southern side and Fingeswar village in the central region as shown in Figure1.

Mosquito collection and meteorological data

Indoor resting mosquitoes were collected from human dwellings, spending 10 minutes in each house, (10 selected

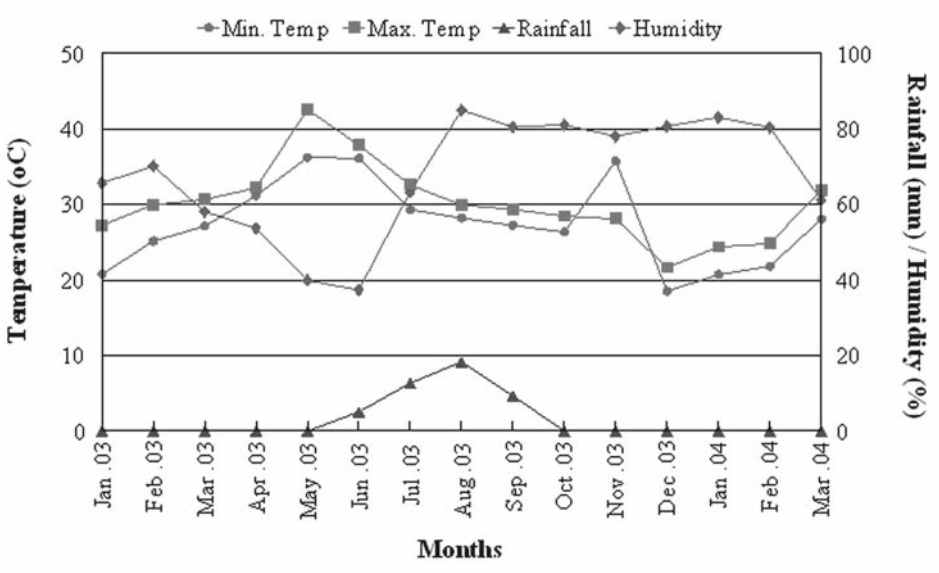


Fig. 2 Meteorological parameters during January 2003 to March 2004 in the block Fingeswar

houses in each area) during 6:00–8:00 hours by using aspirator tube and hand torch at weekly intervals for over a period of 15 months. Mosquitoes density was calculated month wise correlated with meteorological parameters and analyzed statistically by Chi-square analysis in Costat software. Identification was done by using standard pictorial keys following Rao (1984), Das et al. (1991) and Reuben et al. (1994). Meteorological data (temperature, humidity and rainfall) was recorded every day from the region.

The meteorological data during the study period viz. January 2003 to March 2004 show that the minimum temperature varied from 18.52ºC in December to 36.21ºC in May 2003, whereas the maximum temperature ranged between 21.08ºC and 42.60ºC. The total annual rainfall recorded was 2347.4 mm. Average monthly rainfalls ranged between 34.67 and 94 mm. The highest humidity was recorded in August (84.92%) and lowest in May (37.34%) 2003 as depicted in Figure 2.

Identification of mosquito blood meals

Agar gel diffusion method for the identification of mosquito blood meals was used following Collins et al. (1991) using standard antiserum procured from The Serological Institute, Kolkata.

Results

In block Fingeswar 13,248 mosquitoes were collected by spending 286 man-hours from the studied area with an average person hour density of 46.32. In the collections made, genus *Anopheles* comprised of 5 species (51.09%), *Culex* of 2 species (41.70%), while *Armigeres subalbatus* (6.92%) and *Aedes albopictus* (0.29%) were alone. Among anopheline, *A. subpictus* was the dominant species (25.81%) followed by *A. annularis* (8.68%), *A. barbirostris* (6.76%), *A. culicifacies* (5.41%) and *A. pallidus* (4.11%). Among culicine *Culex quinquefasciatus* (38.38%) and *C. vishnui* (3.32%) were prominent. *A. subalbatus* (6.92%) and *A. albopictus* (0.29%) were other species present. The vector species of malaria viz. *A. culicifacies* and *A. annularis* (Ghosh et al. 1985) comprised 14.09% of the total indoor mosquito collections (Fig. 3). Mostly, the density of all the species was high in month of August, September and October 2003 and low in month of May and June 2003. Two peaks of mosquito densities were observed during the study period, first in February and March 2003, whereas second peak was observed in August and October 2003. Except for May and June 2003, the density was invariably higher (Table 1). There was a significant positive correlation between temperature and density of *A. culicifacies* (0.048) and *A. annularis* (0.0007).

Table 1 Person hour Density of mosquito species in block Fingeswar during January 2003 to March 2004

Species	2003 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	2003 Dec	2004 Jan	Feb	Mar	Average density
A. annularis	7.47	6.83	4.80	1.45	0.40	0.75	3.50	5.50	3.00	5.40	4.65	7.20	4.49	3.35	2.50	4.10
A. barbirostris	2.10	1.89	4.25	1.85	0.75	0.45	0.35	1.75	2.10	6.13	5.25	4.20	3.20	2.80	10.25	3.13
A. culicifacies	7.24	6.39	1.30	0.35	0.00	0.10	2.10	4.55	3.31	6.73	2.00	4.20	1.15	1.65	0.85	2.63
A. pallidus	6.53	5.00	1.05	0.45	0.00	0.10	1.75	3.15	1.37	2.60	1.55	2.15	0.80	2.30	0.85	1.91
A. subpictus	4.41	7.72	16.10	11.60	4.25	3.15	2.85	20.65	12.25	15.93	19.30	15.95	14.30	13.35	17.05	11.96
C. quinquefasciatus	8.00	12.00	22.50	10.65	5.10	5.25	23.55	29.05	11.13	24.87	22.30	22.15	20.80	20.30	27.45	17.78
C. vishnui	2.71	4.17	3.20	0.65	0.05	0.90	1.40	2.70	3.82	3.06	0.25	0.50	0.60	0.35	0.00	1.54
A. subalbatus	4.29	3.00	3.70	2.15	0.15	0.55	4.90	5.80	2.87	3.33	2.75	3.90	3.85	2.95	4.00	3.21
A. albapictus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.13
Density	42.71	47.00	56.90	29.15	10.70	11.25	40.40	73.50	41.75	68.10	58.05	60.25	49.15	47.05	62.95	46.32

The mean person hour density of different mosquito species recorded included, *Anopheles subpictus* (11.96), *A. annularis* (4.10), *A. pallidus* (1.91), *A. culicifacies* (2.63), *A. barbirostris* (3.13), *C. quinquefasciatus* (17.78), *C. vishnui* (1.54), *A. subalbatus* (3.21) and *A. albopictus* (0.13) as shown in Table 1. *Anopheles subpictus* showed annual average density of 11.96 and was highest in the month of August 2003 (20.65), whereas lowest density was observed in the month of July 2003 (2.85). *Anopheles subpictus* was the dominant (25.81%) species in mosquito composition at block Fingeswar; this species dominated in village Roba (13.66/man hr). *A. annularis* density was highest in the month of January 2003 (7.47) while lowest in the month of May 2003 (0.40). *A. pallidus* was abundant in the month of January 2003 (6.53) and lowest in June 2003 (0.10). It was not recorded in May 2003. *A. culicifacies* the prime vector for malaria transmission had the highest density in the month of January 2003 (7.24).

A. barbirostris was most abundant in the month of March 2004 (10.25) and lowest in July 2003. *Culex quinquefasciatus* the prime vector of *Wuchareria bancrofti* in this region (Dixit et al. 2002) recorded highest density in August 2003 (29.05) and lowest in the month of May 2003 (5.10). *Culex vishnui* was highest in February 2003 (4.17) and with lowest densities in March 2004 in the area. *A. subalbatus* was recorded with average density of 3.21 in the region (Table 1). *A. albopictus* was recorded during rainy months.

Monthly prevalence of mosquito densities in different villages of the block is presented in Table 2. Average density was highest in Fingeswar (48.59), followed by Roba (47.55), Borsi (46.38), Borid (45.29) and Sendar (42.23). However, village-wise density pattern revealed that the density was high in village Borid (78.50/man hr), followed by Borsi (75.75/man hr), Roba (75.25/man hr) in August 2003; in Fingeswar (75.75/man hr) in December 2003, and in Sendar (66.67/man hr) in October 2003, respectively. Season wise highest density was recorded (58.27/man hr) in the post monsoon season followed by monsoon season (41.72/man hr) and in pre monsoon season (35.36/man hr) as shown in Table 3. The host feeding preference pattern studied for *A. annularis* and *A. culicifacies* in the block revealed zoophilic nature of both the species. Only single specimen of both the species was found positive for mixed blood feeding as shown in Table 4.

Discussion

The present study was undertaken in the tribal block Fingeswar of Raipur district to understand the distribution pattern of different mosquito species. The entomological survey carried out between October 2002 and March 2004 revealed 9 species. Of them 5 were *Anopheles* species, 2 *Culex* and one each *Armigeres* and *Aedes* species. Husainy (1986) recorded 19 *Anopheles* species in Bastar district. Kulkarni and Rajput (1988) and Kulkarni (1990) have reported 48 culicine and 17 anopheline species, respectively in indoor and outdoor collection. The higher density of the anopheline mosquitoes in the present study in the region

is perhaps an outcome of favorable ecological conditions, rich forest cover and congenial breeding environment (presence of large number of ponds and river tributaries) and is attributed to high malaria incidence in this part of the state. High incidence of malaria is also being reported in the adjoining state of Orissa (RMRC 2003–2004; Dash et al. 2000).

The total average indoor resting density recorded (46.32/man hr) in the region seems to be fairly high. Separately, the average density for *Anopheles* and *Culex* was 30.80 and 12.95, respectively. Kulkarni (1990) encountered *A. culicifacies* and *A. fluviatilis* as important vector in Bastar region present in indoor and outdoor collections, respectively. *A. subpictus* and *A. culicifacies* were the dominant mosquitoes collected in the indoor catches. Density of anopheline species was 66.79. Sharma and Prasad (1991) observed high density (11.3–125.1) of *A. culicifacies* in rural areas of Shahjahanpur in Uttar Pradesh.

The monsoon season starts in this region from middle of June and last till mid of October. The mosquito's incidence was high in post monsoon season (58.27/man hr) as compared from monsoon season (41.72/man hr) and pre monsoon season (35.65/man hr). *Anopheles subpictus* was dominated in pre monsoon season. Malakar et al. (1995) recorded *A. subpictus* during pre monsoon period in West Bengal. Mahesh and Jauhari (2004) found *A. subpictus* abundantly in summer and monsoon seasons and less in winter seasons in Doiwala area of Uttaranchal. Tiwari et al. (1997), while working on indoor resting *Anopheles* in Allahabad, encountered 14 *Anopheles* species with *A. subpictus* being dominant followed by *A. culicifacies*, *A. annularis* and *A. pallidus*. Out of 9 vector species of malaria, only two, *A. culicifacies* and *A. annularis* could be

Table 2 Village wise mosquito densities in block Fingeswar during January 2003 to March 2004

Months	Villages				
	Borid	Borsi	Fingeswar	Roba	Sendar
Jan-03	45.50	44.33	33.75	49.33	42.67
Feb-03	59.33	38.00	46.25	67.00	32.50
Mar-03	51.00	54.50	62.25	62.50	53.25
Apr-03	29.50	26.50	30.25	32.00	27.50
May-03	09.00	10.00	12.25	12.00	10.25
Jun-03	10.75	10.50	14.25	11.00	09.75
Jul-03	36.00	42.75	37.00	42.25	44.00
Aug-03	78.50	75.75	74.50	75.25	63.50
Sep-03	39.00	38.67	48.67	41.33	42.00
Oct-03	78.00	72.67	61.33	60.67	66.67
Nov-03	61.75	61.75	59.75	57.75	49.25
Dec-03	57.75	56.50	75.75	58.75	52.50
Jan-04	51.50	47.50	53.00	45.75	48.00
Feb-04	45.00	48.50	53.25	43.25	45.25
Mar-04	62.50	72.00	68.75	59.00	52.50
Average MHD	45.29	46.38	48.59	47.55	42.23

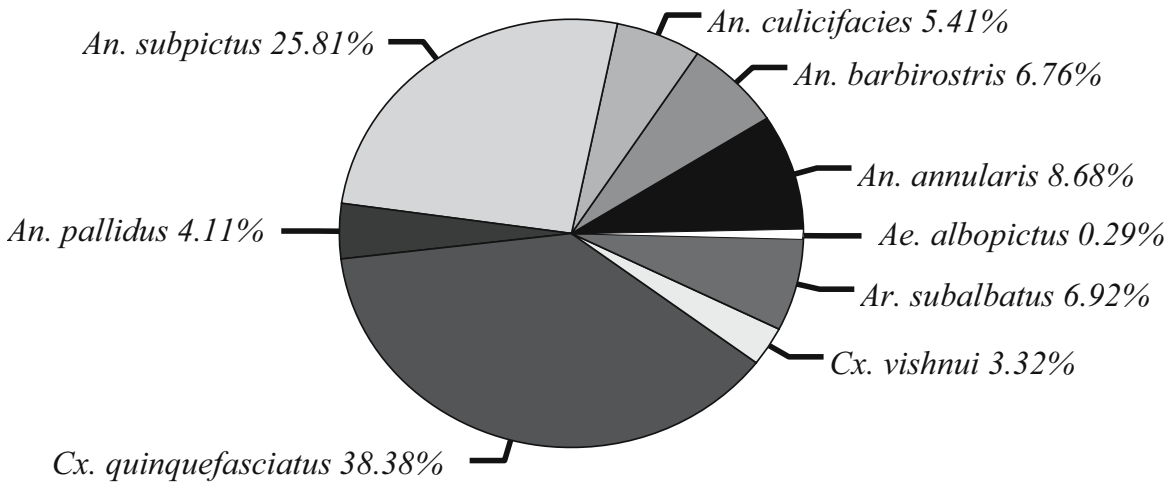


Fig. 3 Composition of mosquito species in block Fingeswar

Table 3 Seasonal density of mosquito species in block Fingeswar during February 2003 to January 2004

Species	Pre monsoon (Feb–May)	Monsoon (Jun–Sep)	Post monsoon (Oct–Jan)
A. annularis	3.28	3.19	5.43
A. barbirostris	2.19	1.11	4.60
A. culicifacies	1.89	2.47	3.31
A. pallidus	1.54	1.61	1.71
A. subpictus	9.97	9.59	16.32
Culex quinquefasciatus	12.57	17.56	22.37
C. vishnui	1.96	2.12	0.96
Armigeres subalbatus	2.23	3.56	3.47
A. albopictus	0.00	0.50	0.00
Total	35.56	41.72	58.27

recorded in the study region comprising 14.39% of the total *Anopheles* collection. *Anopheles annularis* was found more during monsoon season. Husainy (1986) also reported more number of *A. annularis* in rainy season (68%) in old Bastar district of Chhattisgarh. *Anopheles culicifacies*, the major vector of malaria in India (Sharma 1998), was high during monsoon and post monsoon season, and rarely observed in pre monsoon or summer season. Similar observation was made by Bansal and Singh (1993) in Bikaner district of Rajasthan. Malakar et al. (1995) reported peak density of *A. culicifacies* during April and May months in the foot-hills of Darjeeling district. A positive correlation between the density of *A. culicifacies* and temperature was also observed during the present study ($p < 0.01$).

The average density was high in August–September and February–March 2003, declined gradually and was lowest in summer season. Kulkarni (1990) reported two peaks, one in July–August and another in February-March. However, in Doiwala area of Doon valley in Uttaranchal, the average density was high in July–August, which declined later and was lowest in the month of December (Mahesh and Jauhari 2004). Several of the climatic factors viz. rainfall, humidity and temperature and biological activities like housing style, pattern of villages, larval breeding grounds, socioeconomic conditions and adopted control measures are found to be the regulatory factors of indoor mosquito density in this study.

Saxena et al. (1992) reported *A. culicifacies* in all the months except May in Bilaspur zone of Chhattisgarh state. Baghel et al. (2008) reported indoor mosquito's density highest in August (94.10/man hr), followed by September (91.60/man hr) and lowest in June (15.85/man hr) in Chhura block of Raipur district. Joshi et al. (2005) while studying density distribution of *Anopheles* mosquito in irrigated and non-irrigated areas of Thar desert Rajasthan, reported the presence of 4 *Anopheles* species in rainy and winter season. *Anopheles barbirostris* was recorded mostly in cattle sheds in post monsoon season and lowest in pre monsoon season. Baruah et al. (2004) reported nine species of *Anopheles*

Table 4 Host feeding patterns of *Anopheles annularis* and *Anopheles culicifacies* at block Fingeswar

Anopheles annularis

Shelter type	Number		No. of blood meals positive for								A. I.
	Tested	Positive	Man	Rabbit	Pig	Cow	Buffalo	Dog	Gout	Mixed*	%
Human	55	45	07	05	-	12	15	02	03	-	15.56
Cattle	31	22	04	-	-	11	06	-	01	-	18.18
Mixed	13	04	02	-	-	01	-	-	-	01(C+B)	50.00
Total	99	72	13	05	-	25	21	02	03	01	18.06

Anopheles culicifacies

Shelter type	Number		No. of blood meals positive for								A. I.
	Tested	Positive	Man	Rabbit	Pig	Cow	Buffalo	Dog	Gout	Mixed*	%
Human	53	48	03	02	04	19	16	02	03	-	6.25
Cattle	36	26	06	-	-	09	10	-	01	-	20.69
Mixed	05	03	02	-	-	-	-	-	-	01(C+B)	66.67
Total	94	80	11	02	04	28	26	02	04	01	13.75

*Samples positive for more than one blood source. A.I. = Anthrophilic Index. Figures in parentheses indicate the sources of mixed blood meal (C = Cow, B = Buffalo)

in which *A. philippinensis* (9.5) was abundant followed by *A. barbirostris* (7.2), *A. vagus* (6.3), *A. minimus* (3.7) and *A. culicifacies* (3.0) in Dhansiripar PHC of Dimapur, Nagaland. They noted more *Anopheles* in cattle shed as compared from human dwellings. Malakar et al. (1995) also made similar observation. The host feeding preferences of both *A. annularis* and *A. culicifacies* lends testimony to these observations in the study region. Both the species had mixed blood feed preferences with more zoophilic attitude. Among *Culex* species, *C. quinquefasciatus* was abundantly present in the region followed by *C. vishnui*. Dixit et al. (2002) reported *C. quinquefasciatus* as the principal vector of *Wuchereria bancrofti* and its involvement in transmission of filariasis in Raipur district. Kulkarni and Rajput (1986) reported high prevalence of *C. quinquefasciatus* in human dwellings in Bastar district. High percentage of *C. quinquefasciatus* along with *C. tritaeniorhynchus* was reported in Gorakhpur district by Kanojia et al. (2003) and in north-western Orissa by Chand et al. (1993). *C. vishnui* was recorded in almost all the months of the study and it comprised 0.29% of the total collection. *A. subalbatus* recorded from all villages in every study sites; the breeding sites for *A. subalbatus* are highly polluted water (Rao 1984). Nearly same density for *A. subalbatus* was found during all the study period. *A. albopictus* was sporadic in the region and could be seen only in rainy months. This is the first ever longitudinal study on composition and prevalence of various mosquito vectors in plane region and rice cultivated block of Raipur district and the findings are of immense value for working out vector intervention strategies in the study region.

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