

Anopheline fauna of parts of Tirap district, Arunachal Pradesh with reference to malaria transmission

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In a survey on the anopheline fauna in highly malaria endemic areas of the Tirap district of Arunachal Pradesh, 7476 anophelines belonging to 17 species were collected, including seven species of anophelines which are recognized malaria vectors in India. *Anopheles tessellatus* and *A. jamesii* were recorded for the first time in this area. The parasitological survey revealed that the area was endemic for malaria particularly *P. falciparum*, the slide positivity rate and slide falciparum rate being 25.63 and 19.21 per cent respectively. On dissection of 10 anopheles species, malarial infection was detected in two viz., *A. minimus* and *A. dirus*.

Many areas of Arunachal Pradesh (India) are highly endemic for malaria. Among the districts of Arunachal Pradesh, district Tirap is afflicted with high incidence of malaria^{1,2}. The foci of chloroquine resistant strains of *Plasmodium falciparum* were detected from this district^{3,4}. A preliminary survey on anophelines in Arunachal Pradesh (earlier the North East Frontier Agency or NEFA) was conducted during the pre-DDT era⁵. Information on the anopheline species composition and the vectorial status in the post-DDT era are also very limited^{2,6}. As a result of the long-term use of DDT as residual spray under the National Malaria Eradication Programme and other developmental activities including deforestations etc., gross ecological changes have taken place. The change of ecology has influenced the mosquito fauna, vector prevalence, their behaviour etc. In this region, no comprehensive study in these aspects has been undertaken. Therefore, a

study was undertaken in Tirap district of Arunachal Pradesh to determine the composition of anopheline fauna, their relative abundance and role in the current transmission of malaria.

Material & Methods

Study area: Tirap district (undivided-now divided into Tirap and Changlang) forms the south-eastern part of Arunachal Pradesh bordering Dibrugarh district of Assam in the west, Burma on its east, Nagaland in the south and Lohit district in the north. This district covers an area of 7,024 sq/m between 26° 39' and 27° 44' N latitude and 95° 12' and 97° 12' E. longitude with a population of 1,28,050 (as per 1981 census).

The study was undertaken in Namsang, Nampong and Monmao circle of Tirap district during 1986-88 covering a population of about 14,000. These are mostly foothill areas ranging from 1000-1400 ft above sea level. The region is

covered by deep forests traversed by rivulets and hill streams. The people of these areas are Nocte and Wangsoo tribes of Arunachal Pradesh with a few Nepali settlers. Climate is hot and humid with heavy rainfall. These are highly malaria prone areas. Fever survey was carried out in the study area by collecting blood smears from patients with fever during the malaria transmission season (May to October) to detect malaria patients. All patients with fever were administered 600 mg of chloroquine (adult dose). After the examination of blood slides, radical treatment was given to the malaria parasite positive cases.

The entomological survey was conducted during malaria transmission season in six selected localities viz., Namsang, Deomali, Jairampur, Nampong, Namchik and Tengmao and from each locality, one collection was made every fortnight. The collection of mosquitoes was done by suction tubes between 1800 h to 2400 h and a total of 900 h was spent for collection. From each locality 25 night collections were made. The battery-operated CDC miniature light-traps were also use in index localities from dusk to dawn i.e., from 1800 h to 0500 h and a total of 52 trap

night collections (8 trap nights per locality) were made. Human bait collections were made in two localities viz., Jairampur and Namsang to ascertain manbiting rate of mosquitoes and for this collection, 432 h were spent. The search of mosquitoes in the morning was also made from human dwellings. Bednet-traps were also used in a few selected houses of Jairampur area for collection of mosquitoes. Twenty bednet-trap collections were made. The anopheles mosquitoes collected from different sources were identified and recorded. The fresh and live mosquitoes were dissected to detect gland or gut infections with plasmodium.

Periodic larval surveys were made in two localities viz., Jairampur and Namsang, from different waterbodies to detect the breeding of different anopheline species particularly malarial vectors. The larvae collected from different sites were reared separately for successful emergence of the adults so as to trace and record all the stages of the mosquito for confirmed identification.

Results & Discussion

A total of 7476 anophelines comprising 17

Table I. Number of anophelines collected from six different localities by various methods

Species name	Namsang		Deomali		Jairampur			Nampong		Namchik		Tengmao		Total	Per cent
	LT	ST	LT	ST	LT	BT	ST	LT	ST	LT	ST	LT	ST		
<i>A. (Ano) barbirostris</i>	2	2	5	0	3	0	6	2	0	0	2	2	0	24	0.32
<i>A. (Ano) gigas</i>	0	0	0	0	2	0	0	1	0	0	0	2	0	5	0.06
<i>A. (Ano) 'hyrcanus' group</i>	51	15	20	5	70	0	26	40	11	64	12	3	20	337	4.50
<i>A. (Cel) aconitus</i>	0	1	0	0	1	0	1	1	0	0	0	0	0	4	0.05
<i>A. (Cel) annularis</i>	10	8	0	3	8	0	21	5	2	0	5	0	0	61	0.81
<i>A. (Cel) culicifacies</i>	14	3	1	1	5	0	0	7	1	5	0	2	0	39	0.52
<i>A. (Cel) dirus</i>	22	78	18	2	145	351	264	64	40	12	38	40	26	1100	14.71
<i>A. (Cel) jamesii</i>	0	0	0	0	1	0	0	2	0	1	0	0	0	4	0.05
<i>A. (Cel) jeyporiensis</i>	0	0	0	0	1	0	0	0	1	0	2	0	1	5	0.06
<i>A. (Cel) karwari</i>	5	1	2	0	5	0	2	2	3	16	4	0	0	40	0.53
<i>A. (Cel) kochi</i>	40	9	0	2	62	0	33	40	11	24	7	26	13	267	3.57
<i>A. (Cel) maculatus</i>	178	194	54	26	90	0	765	363	501	162	218	44	230	2825	37.78
<i>A. (Cel) minimus</i>	89	170	8	12	0	0	0	0	0	0	0	0	0	279	3.73
<i>A. (Cel) philippinensis</i>	34	401	11	31	20	4	515	18	131	7	14	2	20	1208	16.15
<i>A. (Cel) splendidus</i>	0	0	0	0	2	0	1	1	1	0	0	0	1	6	0.08
<i>A. (Cel) tessellatus</i>	0	0	0	0	3	0	0	2	0	1	0	0	0	6	0.08
<i>A. (Cel) vagus</i>	128	263	90	47	106	0	276	14	141	26	71	38	66	1266	16.93

LT, light trap; ST, suction tube; BT, bednet trap

species were collected (Table I). This includes *A. aconitus*, *A. annularis*, *A. maculatus*, *A. dirus* (*A. balabacensis*), *A. minimus*, *A. culicifacies* and *A. philippinensis* which have been recognized as malaria vectors in India. Of the anophelines collected, the most abundant was *A. maculatus* (37.78%) followed by *A. vagus* (16.93%), *A. philippinensis* (16.15%) and *A. dirus* (14.71). Among the vector species, *A. philippinensis* was predominant followed by *A. dirus* and *A. minimus*. Other species like *A. hyrcanus*' group and *A. kochi* were also present in considerable numbers. During the pre-DDT era, only 6 species of anopheles were recorded in Arunachal Pradesh and *A. minimus* was incriminated as vector⁵. As this study was for a short period of about 6 wk (November, 28, 1955 to January, 14, 1956) and that too in winter, the collection of less species may be justified. In an earlier study conducted in Tirap district during post-DDT era (from February, 1969 to November, 1969), 13 species of anopheles species were collected and *A. balabacensis* was incriminated as vector¹. This survey confirmed the existence of all the species reported by Misra⁵ except *A. minimus*, the

complete absence of which was attributed to large scale use of DDT and other insecticides under NMEP as well as by agriculturists.

A similar survey conducted after a decade reported 18 species of anopheles from Arunachal Pradesh and 13 species were recorded from Tirap district⁷. In this survey also no *A. minimus* had been encountered. Subsequently, in a study conducted in some selected areas of Arunachal Pradesh, 18 species of anopheles were reported but Tirap district was not included in the survey⁸.

In the present study, out of 17 species of anopheles collected, 11 were in conformity with those reported by Sen *et al*¹ and 12 were in conformity with those of Malhotra *et al*⁷. *A. tessellatus* and *A. jamesii* were recorded for the first time from Tirap district.

A comparison of various methods of collection (Table II) reveals that the light-trap was the most productive for sampling anopheline population in this area. In human bait, *A. philippinensis* was collected more than other anophelines. *A. maculatus* was collected more in outdoor resting places than indoor. *A. dirus* (*A. balabacensis*), a

Table II. Comparison in the number of anopheline collection by various methods in the study area

Species	Suction tube	MHD	Light trap	Per trap night	Human bait	MBR	Bed-net traps	Per bed net-trap
<i>A. (Ano) barbirostris</i>	7	0.007	14	0.26	3	0.003	0	0
<i>A. (Ano) gigas</i>	0	0.00	5	0.09	0	0.00	0	0
<i>A. (Ano) 'hyrcanus' group</i>	82	0.09	248	4.76	7	0.008	0	0
<i>A. (Cel) aconitus</i>	2	0.002	2	0.03	0	0.00	0	0
<i>A. (Cel) annularis</i>	28	0.03	22	0.42	11	0.01	0	0
<i>A. (Cel) culicifacies</i>	5	0.005	34	0.65	0	0.00	0	0
<i>A. (Cel) dirus</i>	380	0.42	301	5.78	68	0.07	351	17.55
<i>A. (Cel) jamesii</i>	3	0.003	1	0.01	0	0.00	0	0
<i>A. (Cel) jeyporiensis</i>	4	0.004	1	0.01	0	0.00	0	0
<i>A. (Cel) karwari</i>	10	0.01	30	0.57	0	0.00	0	0
<i>A. (Cel) kochi</i>	71	0.07	192	3.69	4	0.004	0	0
<i>A. (Cel) maculatus</i>	1620	1.80	891	17.13	314	0.36	0	0
<i>A. (Cel) minimus</i>	140	0.15	97	1.86	42	0.04	0	0
<i>A. (Cel) philippinensis</i>	603	0.67	92	1.76	509	0.58	4	0.20
<i>A. (Cel) splendidus</i>	3	0.003	3	0.05	0	0.00	0	0
<i>A. (Cel) tessellatus</i>	0	0.00	6	0.11	0	0.00	0	0
<i>A. (Cel) vagus</i>	771	0.85	402	7.73	93	0.10	0	0

MHD, per man h density; MBR, per man biting rate

major vector in this area was collected in large numbers by bednet-trap. As the morning and day time collections were not satisfactory, the pyrethrum spray sheet collections were not done. The tribals reside in houses called *Moshang (Chang-Ghar)*, the walls and platform of which are made of bamboos without mudplastering. The mosquitoes, after biting at night, easily escape through the numerous openings/gaps in the bamboo walls of bamboo platform. Further, the tribals use the fire *Chullah* (ovens) for cooking and other purposes inside their houses early in the morning (0300 h onwards) which makes the whole house smoky. Because of this, no mosquitoes were found inside the houses during morning or day time.

The parasitological survey revealed that the areas were malarious with high incidence of *P. falciparum* malaria. Out of 3070 blood slides examined, 787 were positive for malaria parasites (590 for *P. falciparum* and the rest *P. vivax*) showing slide positivity rate and slide falciparum rate of 25.63 and 19.21 per cent respectively. In the present study, both *A. minimus* and *A. dirus* were recorded and incriminated as vectors by detecting sporozoites in the salivary gland

(Table III). *A. dirus* were more prevalent near the forest areas whereas *A. minimus* was detected in the areas where DDT spray coverage was poor. Thus, *A. minimus* which was thought to have disappeared from the Northeastern Region of India after the introduction of DDT residual spray operation^{2,9} is still present or is acting as a vector of malaria in some areas with poor or no spray coverage.

In the larval survey, breeding of 9 anopheline species were recorded from two localities viz., Namsang and Jairampur in different breeding habitats (Table IV). From each locality eight species were detected in different breeding habitats. In Namsang area, the breeding of malaria mosquito *A. minimus* was detected from slow moving streams. Similarly, in Jairampur area, the other vector - *A. dirus* breeding was detected in water stored in the hollow of elephant's footprints and slow moving stream water under the shade.

The use of DDT and other conventional insecticides on a wide and massive scale have brought about certain changes in the species composition and possibly also in the bionomics of

Table III. Number of anophelines of different species dissected for gut and gland positivity

Species	No. dissected*	Sporozoite +ve gland	Sporozoite rate (%)	Parity (%)
<i>A. aconitus</i>	3	0	0.00	33.33
<i>A. annularis</i>	47	0	0.00	27.65
<i>A. culicifacies</i>	34	0	0.00	26.47
<i>A. dirus</i>	716	7	0.97	48.46
<i>A. karwari</i>	28	0	0.00	25.00
<i>A. kochi</i>	226	0	0.00	38.05
<i>A. maculatus</i>	2068	0	0.00	57.15
<i>A. minimus</i>	246	1	0.40	43.08
<i>A. philippinensis</i>	782	0	0.00	52.42
<i>A. splendidus</i>	3	0	0.00	0.00

*Only fresh and live mosquitoes dissected
Oocyst +ve gut was zero in all the species

Table IV. Breeding of different anopheline species recorded in two localities of the study area from various habitats

Species	Namsang area				Jairampur Area				
	Hill stream	Stagnant water	Water stored in elephant's foot prints inside jungle		Hill stream	Stagnant water	Water stored in elephant's foot prints inside jungle		
			Shady	Unshady			Shady	Unshady	
<i>A. barbirostris</i>	+	+	—	—	+	+	—	—	+
<i>A. hyrcanus</i> group	—	+	+	—	—	+	+	—	+
<i>A. dirus</i>	—	—	—	—	—	—	+	—	+
<i>A. kochi</i>	+	+	—	+	+	+	—	+	—
<i>A. karwari</i>	+	—	—	+	+	—	—	—	—
<i>A. maculatus</i>	+	—	—	+	+	—	—	+	+
<i>A. minimus</i>	—	—	—	—	—	—	—	—	—
<i>A. philippinensis</i>	—	—	—	+	—	—	—	+	—
<i>A. vagus</i>	—	+	—	+	—	+	—	+	—

+, detected; —, not detected

the vector species. There is great scope for further field studies on this aspect.

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