

Shankargarh (Uttar Pradesh)

Malaria control in quarries was demonstrated in the mining areas of Shankargarh. The knowledge on the sibling species complex in *An. culicifacies* resulted in the malariogenic stratification of Shankargarh bringing out the need for focused work in high risk areas to control malaria. Malaria clinic provided great relief to the villagers and migrant population. Studies on drug sensitivity revealed spread of drug resistant parasites to other parts of the state and neighbouring areas. The field unit has been closed and staff deployed to other field units.

Background

In view of the high incidence of malaria in stone quarry area of Allahabad district, Uttar Pradesh, a unit of IDVC project was opened in 1987 in Shankargarh PHC to understand the dynamics of malaria transmission for control of malaria in Allahabad district and to evaluate the feasibility of bioenvironmental methods of malaria control. Prior to the opening of the field unit, malaria API ranged from 9.05 to 33.86 between 1982 and 1986 and the SPR ranged from 5.7 to 16.9%. In May 1987, initially six villages with a population of 2,090 were selected for the study. The study area was expanded to 107 villages in a phased manner covering a population of 48,540. From 1991 onwards, the study area was reduced to 36 experimental villages (population 16,302) and four control villages (population 1973).

Activities, Progress and Achievements

Bioenvironmental control of malaria

The major components of the control strategy were source reduction, case detection and treatment, and health education.

Source reduction

Various intervention measures were applied to permanent as well as temporary breeding sites. The measures included: (i) manipulation and modification of breeding sites by draining wastewater, covering/

cleaning domestic containers, applying EPS beads to unused wells (Fig.1), filling/levelling of stagnant unused water bodies/pits (Fig. 2), construction of soakage pits for collection of domestic wastewater; (ii) environmental improvement, which included establishment of nurseries for plantation of trees in water logging areas, and encouraging villagers for use of smokeless *chulhas*/solar cookers; and (iii) use of larvivorous fish *G. affinis* and Guppy (*P. reticulata*) in permanent breeding sites like ponds and wells. All these activities were carried out with the help of the local people, with a view to improve overall development of the community.

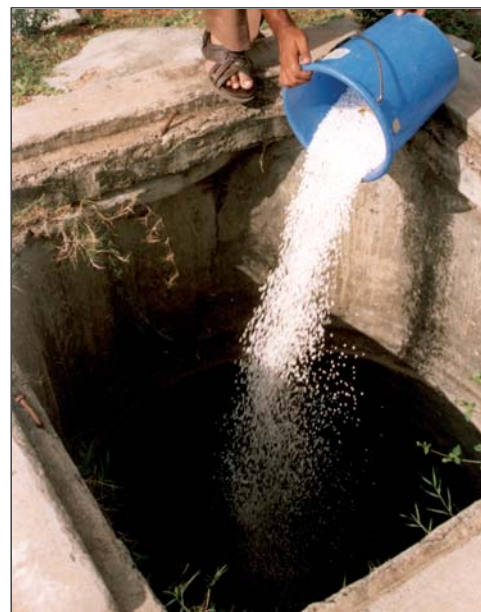


Fig. 1: Release of EPS beads to prevent mosquito breeding



Fig. 2: Source reduction by filling earth

Case detection and treatment

Blood smears of all fever cases made either by active or passive collection were examined in the laboratory and all malaria positive cases were administered appropriate treatment. Active door-to-door surveillance was carried out on weekly basis in the study villages, which revealed high incidence of malaria. On an average the slide positivity rate and slide falciparum rate were higher in active collection as compared to malaria clinic. *P. falciparum* incidence was higher in active surveillance than that reported in the malaria clinic.

Health education

With a view to bring awareness in public regarding bioenvironmental control strategy, health education was emphasised. Since literacy rate in this area was very low and people were from low socio-economic stratum, sustained efforts were made to motivate people by organising health camps and demonstrations, group meetings, exhibitions, video-films, writing slogans on walls and by door-to-door campaigns frequently. The impact of health education was very good. Most local people knew about *P. vivax* and *P. falciparum* malaria, chloroquine tablets, larvivorous fishes and methods of malaria control.

Malariogenic stratification of District Allahabad

Topographically, Allahabad district can be divided into three parts—Ganga tract or Gangapar, trans Yamuna tract or Yamunapar and Doaba area between Ganga and Yamuna river (Fig. 3). Not only topography but

also incidence of malaria observed in different parts of the district was also variable. To understand the causes for the differential malaria situation, a study on sero-epidemiology and the distribution of *An. culicifacies* sibling species was carried out in the district. Twenty-seven villages of different epidemiological and ecological situations were surveyed twice during the transmission and non-transmission seasons in 1989 and 1990.

The slide positivity rate and the slide falciparum rate recorded for Yamunapar, Doaba and Gangapar areas were 8.8, 6.9, 2.8% and 2.4, 1.8, 1.1%, respectively. Likewise, the values of infant parasite rate and infant falciparum rate, child parasite rate (CPR), and child falciparum rate were higher for Yamunapar area (7.7, 5.1, 5.0 and 2.9 respectively) as compared to Doaba (0, 0, 1.7, and 1.4) and Gangapar zones (0, 0, 1.5, and 1.0). Serological data also indicated the same trend. Man hour density of *An. culicifacies* in Yamunapar area ranged between 3.5 and 59, whereas it varied from 0 to 8.5 and 2.3 to 24.5 in Gangapar and Doaba zones respectively. Similarly, per room density ranged from 19.6 in Yamunapar to 2.3 in Gangapar. Sibling species A, B and C of *An. culicifacies* are present in the area. The proportion of species A, which is a well-established malaria vector, was maximum in Yamunapar zone, being 37.4%, followed by in Gangapar with 12.5% and in Doaba with 12%. Composition of species B was 51.4% in Yamunapar, 65.6% in Gangapar and 87.5% in Doaba, while species C made up 11.2% in Yamunapar, 21.9% in Gangapar and 0.5% in Doaba. On the basis of *An. culicifacies* sibling species composition and sero-epidemiological findings, Allahabad district was stratified into two zones—Yamunapar area comprising of nine PHCs with high transmission of malaria, and Gangapar and Doaba

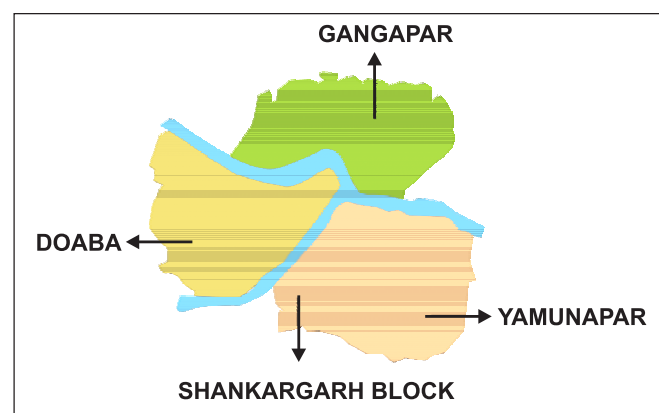


Fig. 3: Map of Allahabad district showing three ecological zones

Table 1: Frequency of G-6-PD deficiency in Shankargarh

Month	No. of samples screened			No. of samples found deficient			% deficient samples
	Male	Female	Total	Male	Female	Total	
Jul 1990	15	8	23	1	0	1	4.3
Aug	126	44	170	1	0	1	0.6
Sep	20	7	27	0	0	0	0
Oct	22	8	30	0	0	0	0
Jan 1991	83	16	99	1	0	1	1.01
Feb	122	44	166	3	1	4	2.4
Mar	115	36	151	2	0	2	1.3
Apr	107	61	168	1	1	2	1.2
Total	610	224	834	9	2	11	1.8

comprising of 11 and eight PHCs respectively with low transmission of the disease (Fig. 3).

Bionomics of malaria vectors

Vector densities were monitored fortnightly. Adult mosquitoes were collected either by hand catch method or by total catch to determine the species composition. In the area among the anopheline population, *An. culicifacies* was most abundant, followed by *An. annularis* and *An. subpictus*. As paddy cultivation in the area starts in July, the density of *An. culicifacies* was highest in the month of August. After October the density comes down as the paddy plants grow above 30 cm and start branching. The man hour density of all anopheline species in cattlesheds was almost double than those in human dwellings. This is due to the fact that the anophelines are basically cattle feeders.

Frequency of G-6-PD deficiency

From persons reporting to the malaria clinic during July 1990 to April 1991, a total of 834 blood samples were collected and processed for screening of G-6-PD enzyme deficiency by fluorescent spot test method. Among males, nine out of 610 (1.5%) were deficient in G-6-PD enzyme, and in females two out of 224 (0.9%) were deficient in Shankargarh area (Table 1).

Chloroquine sensitivity of *P. falciparum*

During November–December 1988, a 28-day *in vivo* test was conducted using standard WHO method to

determine susceptibility status of *P. falciparum* isolates in the area. In all 47 cases were followed-up and resistance was detected in 11 cases at R-II/R-III level and in nine cases at R-I level. A similar study was conducted five years later when 54 cases were followed-up, out of that 23 were found resistant to chloroquine, indicating that the resistance level remained the same.

Host specificity of mosquitoes

In the year 1991, 2005 mosquito blood meal samples were collected from different experimental villages and were processed in the laboratory by gel diffusion method to identify the source of blood meal. Only six out of 829 samples of *An. culicifacies*, one out of 332 samples of *An. subpictus* and five out of 249 samples of *Culex* sp. were found positive for human blood, giving HBI value of 0.01, 0.003, 0.02 respectively. Of the 551 and 44 samples of *An. annularis* and *An. stephensi* tested respectively, none showed positive reaction with human antisera.

Field evaluation of biolarvicides

Two biolarvicides—*B. sphaericus* and *B. thuringiensis israelensis* were field tested @ 0.5 g/m² against the immature stages of mosquitoes in stone quarries. Results showed that both the biocides were effective in controlling anophelines and culicines for initial three days after the application. However, *B. thuringiensis israelensis* (Table 2) gave >90% reduction up to three days and was better than *B. sphaericus*. Efficacy of *B. thuringiensis israelensis* came to zero on Day 10, and *B. sphaericus* became ineffective on Day 14. Thus,

Table 2: Results of field-testing of *B.t. israelensis* in stone quarries

Day	Water with patchy vegetation Larval den.(III & IV) per dip			Water with dense vegetation Larval den.(III & IV) per dip			Water with no vegetation Larval den.(III & IV) per dip		
	Cont.	Expt.	% reduct.	Cont.	Expt.	% reduct.	Cont.	Expt.	% reduct.
0 day (pre-treatment)	0.1	0.07	–	0.42	–	–	1.55	–	–
1 day post-treatment	0.3	0.03	84	0.7	0.01	95	0.92	0.05	97
2 day post-treatment	1	0.3	56	1.1	0.05	86	0.62	0.02	98
3 day post-treatment	1	0.02	97	2.5	0.02	98	1.20	0.2	91
7 day post-treatment	2.1	1.53	0	6.5	0.6	71	1.60	0.5	80
10 day post-treatment				7	1.8	22	1.60	0.6	78
Dose applied		0.5 g/m ²			0.5 g/m ²			0.5 g/m ²	
Size of quarry		116 m			120 m			57 m	
Water depth		0.7 m			0.6 m			0.6 m	
Breeding		Mixed (An.76%, Cx .24%)			Mixed (An. 23%, Cx .77%)			An.	
pH of water		10.2–10.6			11.5–12.3			11.5–11.7	
Water quality		Clear water			Clear water			Clear water	

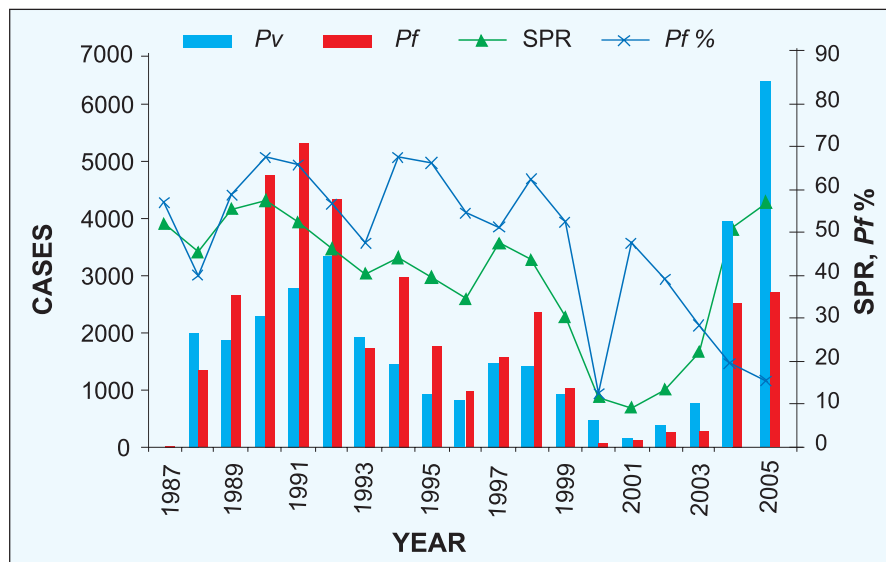


Fig. 2: Data of malaria clinic at Shankargarh from 1987–2005

though *B. thuringiensis israelensis* efficacy was better than that of *B. sphaericus* initially, the efficacy of *B. sphaericus* lasted for more days.

Malaria clinic

The malaria clinic located at the field unit provided malaria diagnostic and treatment services to the popu-

lation. The records of malaria clinic from 1987 to 2005 are given in Fig. 2. The SPR was maximum in 1990 (57.5%) and minimum in 2001. The Pf% was highest in 1990 and lowest in 2001. Till 1999 the SPR was above 30%, but since then there has been a considerable decline in SPR. Since 2003 the SPR has been showing a rising trend.

