

# Car Nicobar (Andaman & Nicobar Islands)

- Demonstration of bioenvironmental control using sluice valve gates
- Discovery of indigenous larvivorous fish—*Ophiocara aporos*
- Use of insecticide-treated bednets by the defence personnel
- Genetic markers in Jarawas, Nicobarese and Onges tribes
- Biology of *Anopheles sundaicus*

## Background

In 1989, 3,810 malaria cases were reported from Car Nicobar Island with an API of 194.4. To study the transmission dynamics of Island malaria transmitted by *An. sundaicus* and evaluate the feasibility of bioenvironmental strategy for malaria control, a field unit was established in Car Nicobar in 1989.

## Activities, Progress and Achievements

### Bioenvironmental control of malaria

Bioenvironmental control strategy was evaluated as an alternative strategy at Car Nicobar Island since September 1989. Water collection sites were filled with earth work and leveled and biological control mainly using larvivorous fish and biolarvicides was carried out. Large-scale production of *G. affinis* was achieved and fish were released in breeding habitats of *An. sundaicus*. *B. sphaericus* gave excellent control of *An. sundaicus* breeding in marshy, mangrove and inaccessible areas as 94.8 to 100% reduction in III and IV instar larvae was observed up to 21 weeks with a bi-weekly reapplication. Installation of one way sluice gate in the creek stopped the flow of sea water to the creek and decreased the salinity of the creek water that allowed the establishment of *G. affinis* in the creek, reduced the breeding of *An. sundaicus* to a very low level vis-à-vis control in Teetop and Sawai creek areas. Nicobari tribal communities were motivated and involved in various environmental manage-

ment methods. Over the years, with a better understanding of the transmission dynamics of malaria and introduction of bioenvironmental control strategy, the API came down from 19.4/1000 in 1989 to 4.3/1000 in 2002. Implementation of all the activities reduced mosquito breeding and there was a significant impact on malaria transmission (Fig. 1).

### Prevalence of malaria in Jarawas, a primitive tribe of Andaman & Nicobar Islands

Jarawas are a primitive tribe of Andaman and Nicobar Islands who inhabit the jungles of South and Middle Andaman in three groups/bands. A parasitological and entomological survey was carried out in the area inhabited by the Jarawas. The areas surveyed were RK Nallah, Bada Balu, Kadamtala, Poona Nallah, Lakra Lungta and Dhani Nallah. Results of the parasitological survey indicated a high prevalence of *P. falciparum* malaria in the area. Of 179 slides examined, 30 slides were positive and all cases were of *P. falciparum*. The SPR, SFR and Pf% were 15.75, 15.75 and 100% respectively (Das *et al.*, 2005). This is the first record of occurrence of malaria among Jarawas in Andaman and Nicobar Islands.

### Duffy blood group study in the primitive tribes of Andaman & Nicobar Islands

Andaman & Nicobar Islands are the home of six primitive tribes namely Great Andamanese, Onges, Jarawas and Sentinelese of Negrito race and Nicobarese

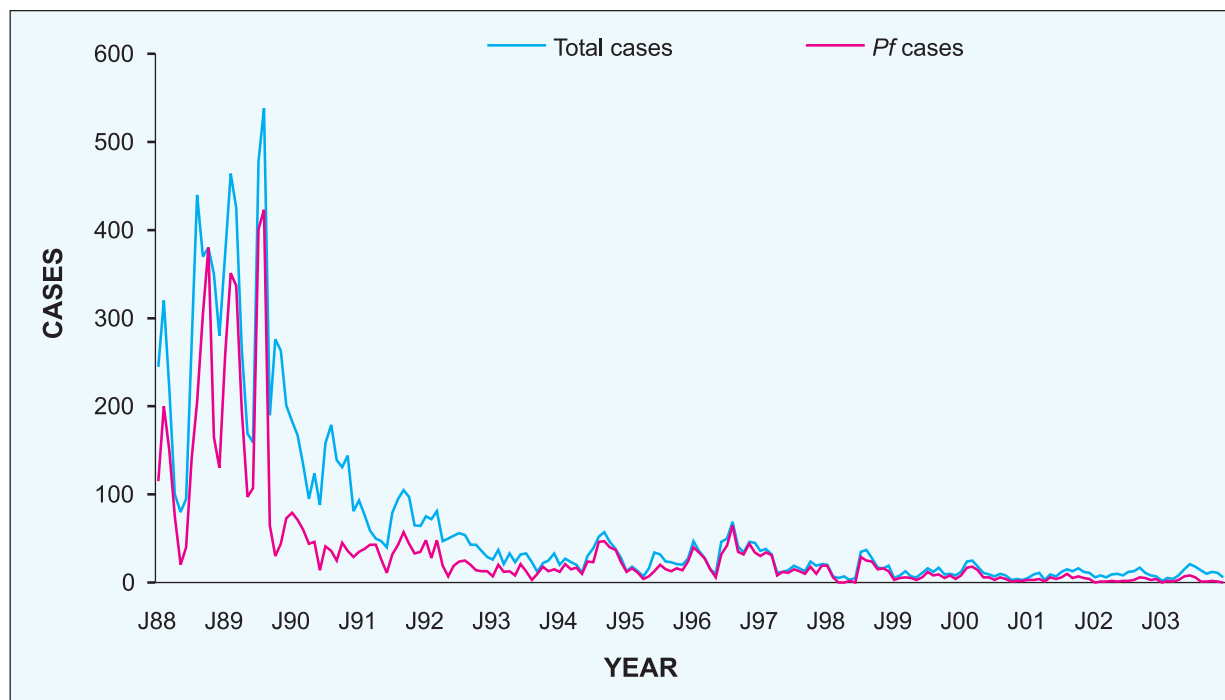


Fig. 1: Impact of bioenvironmental control on malaria in Car Nicobar Island

and Shompens of Mongoloid race. The Negrito tribes in Andaman Islands are probably the most primitive communities in India. The Nicobarese and the Shompen tribes are confined to Nicobar group of Islands. The study found that of four primitive tribes found in Andaman & Nicobar Islands, two bands of Jarawas are duffy negative, whereas Great Andamanese, Onges and Nicobarese are duffy positive (Das *et al.*, 2005). People of the former tribe are refractory to *Pv* infection whereas other three tribes are susceptible to *Pv* and *Pf* infections.

### Investigation of malaria outbreak

Investigation of an outbreak of malaria in Car Nicobar was carried out in 2002. All the fever cases were investigated. The blood smear negative cases were also tested with ICT kits. The parasite density was also calculated. The details of the epidemiological case sheet included symptoms of the disease, work place, use of personal protection measures against mosquito bites, movement in the last one month, etc. In all, seven fever cases were reported among the service personnel from 14–24 September 2002. Out of these, six were positive for malaria by blood smear and ICT test conducted at the field unit, Car Nicobar. The high incidence of malaria in the Air Force Base during the study period clearly demonstrated that there was an epidemic of malaria during this period. Following this,

the preventive measures were undertaken to control the outbreak which included prevention of mosquito breeding through antilarval measures, impregnation of mosquito nets with an insecticide, fogging, health education, early diagnosis and prompt treatment, monitoring of health of casual labourers, and establishing close liaison with the local civil health authorities.

A retrospective study was also undertaken to identify causes of malaria epidemic. These were lack of antilarval operation in the affected area, movement of the service personnel to the high transmission civilian area and multi-drug resistance of *P. falciparum*.

### Survey of anopheline fauna

In Andaman and Nicobar Islands, urbanisation and deforestation have been the important developmental activities. Realising the impact of environmental changes on species prevalence, a mosquito fauna survey was carried out to update the information on anopheline fauna and mosquitoes in different islands of A&N Islands. Thirty-eight species of mosquitoes belonging to eight genera were collected from South, Middle and North Andaman. Eighteen anopheline species were collected from Andaman Island. The most prevalent species were *An. vagus*, *An. kochi* and *An. sundanicus*. From Nicobar group of Islands, 35

species of mosquitoes belonging to 10 genera were collected (Das *et al.*, 1998) including eight anopheline species. The mosquito fauna of Jarawa reserve area and Kalamtala (Middle Andaman) were surveyed. The following anopheline species were found: *An. aitkeni*, *An. barbirostris*, *An. balabacensis*, *An. barbumbrosus*, *An. dirus*, *An. insulaeflorum*, *An. kochi*, *An. roperi*, *An. sundaicus* and *An. vagus*.

### Bioecology of *An. sundaicus* and *An. philippinensis*

Bioecology of the main malaria vector, *An. sundaicus* was studied in detail in creek and non-creek areas of Car Nicobar Island. The salient features are given in Table 1. Studies on bioecology of *An. philippinensis* (*nivipes*) was carried out in eight islands of the Anda-

man group. It was found that *An. philippinensis* (*nivipes*) preferred to rest and bite outdoors. Most biting was observed during 1800 to 2100 hrs on both cattle and human baits (Fig. 2). Breeding of *An. philippinensis* (*nivipes*) was recorded in slow moving streams followed by ponds with vegetation. The breeding sites infested with *Chara* and *Spirogyra* algae were most favourable whereas those with *Lemna* and *Oscillatoria* were unfavourable for the proliferation of this species. The breeding association of *An. philippinensis* (*nivipes*) was found with seven other anopheline species (Das *et al.*, 2003).

### Evaluation of *B. sphaericus*

The larvicidal activity of *B. sphaericus* was evaluated against *An. sundaicus* larvae in different mosquito

Table 1: Bioecological features of *An. sundaicus*

S No.	Creek area	Non-creek area
1.	Breeding ecology* Creeks, coral cavities, ponds infested with putrefying masses of algae, mangrove cutting area, mangrove pools, wells	Cement tanks, ponds, pools, wells, marshy area
2.	Resting habit Indoor-cattleshed, <i>Copra Machan</i> , outdoor-Keoribush ( <i>Pandanus larum</i> ), coconut stumps ( <i>Cocosnucifera</i> ), dry coconut leaves, dry banana leaves ( <i>Musca paradisisea</i> )	Cattleshed, <i>Copra Machan</i>
3.	Biting habit Bimodal biting activity—First peak between 2230 to 2400 hrs. Second peak between 0200 and 0300 hrs. Indoor man biting was slightly higher than outdoor	Peak biting between 2100 and 2200 hrs
4.	Feeding habit Predominantly zoophagic pigs, cows, humans <i>Anthropophilic Index</i> : Rainy season : 0.5 Summer season : 0.87	Predominantly zoophagic pigs, cows, humans Rainy season : 0.62
5.	Sporozoite rate 0.001	Nil
6.	Susceptibility to insecticide Susceptible to DDT (4%), deltamethrin (0.05%), lambda-cyhalothrin (0.05%), propoxur (0.1%)	Susceptible to DDT (4%), deltamethrin (0.05%), lambda-cyhalothrin (0.05%), propoxur (0.1%)
7.	Species complex Cytotype D	Cytotype D

\*Salinity: The lowest chloride content was 0.08 g/L in a cement tank. The highest chloride content was 12 g/L at Kimious mangrove pool; pH: It prefers to breed in slight acidic to alkaline water. The pH range varies from 6.3 to 7.5.

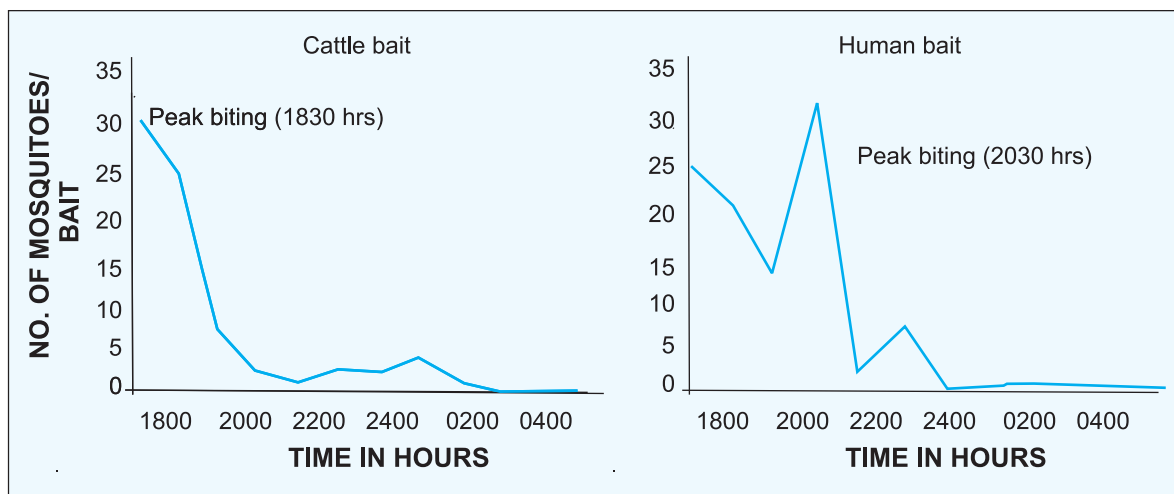


Fig. 2: Biting habit of *An. philippinensis* in Hutbay

breeding habitats like marshy area, mangrove area, coconut garden pools and creeks. The biolarvicide was applied @ 1 g/m<sup>2</sup> surface area in these habitats. *B. sphaericus* gave excellent control of *An. sundaicus* breeding in marshy, mangrove and inaccessible areas and 94.76 to 100% reduction in III and IV instar larvae of *An. sundaicus* was maintained up to 22 weeks with a reapplication every two weeks after that the habitats dried up.

### Evaluation of mosquito repellent action of natural oils

A field study was carried out to evaluate the mosquito repellent action of *Cymbopogon martinii martinii* Stapf var *sofia* oil in tribal villages of Car Nicobar Island. Results revealed that application of 1 ml of the oil provides 98.7% protection indoors and 96.52% outdoors during 12 h period of observation from the bites of *An. sundaicus*. *C. martinii martinii* Stapf var. *sofia* oil is an indigenous product, its application is safe and can be widely used for protection from malaria (Das and Ansari, 2003).

### Evaluation of cyfluthrin-impregnated bednets

Cyfluthrin-impregnated bednets were evaluated in the defense establishment of Brich Gunj (Port Blair), INS Kardip (Kamorta) and Campbell Bay of Andaman & Nicobar Islands. Since *An. sundaicus* is known to form local population and malaria transmission, therefore, the trials were carried out in different island ecosystems. The bednets were impregnated with cyfluthrin at 50 mg/m<sup>2</sup> dose. Treated nets prevented

biting of *An. sundaicus*. Due to repellency of cyfluthrin on *An. sundaicus* the mosquitoes shifted from indoor to outdoor biting on animals. But due to the impact of cyfluthrin the density of *An. sundaicus* gradually reduced to a lower level, the biting however continued. It is also concluded that if the cyfluthrin-impregnated bednets are continued over a long period of time, population of *An. sundaicus* gets adversely affected. This interrupts malaria transmission locally. Cyfluthrin-treated bednets holds a good promise in controlling *An. sundaicus* transmitted malaria in A&N Islands (Fig. 3).

### Survey of filariasis

A filariasis survey was carried out in Nicobar group of Islands among the Nicobarese and settlers. Periodicity study among the microfilariae carriers revealed the presence of two distinct forms of *Wuchereria bancrofti* infection—nocturnally periodic form and diurnally sub-periodic form. The latter form of infection was found among the Nicobarese (tribal) and the nocturnally periodic form was observed among the settlers and migratory labourers. Microfilariae rate in different areas of Nicobar district is given in Table 2. At Chowra, Teresa and Nancowry group of Islands *Ochlerotatus niveus* was incriminated as the vector for transmitting diurnally sub-periodic forms of *W. bancrofti*. *Cx. quinquefasciatus* was also incriminated as the vector for transmitting *W. bancrofti*. DECC tablets were distributed to the microfilariae positive cases.

### Evaluation of rapid filariasis test

The ICT filariasis test for whole blood analysis was

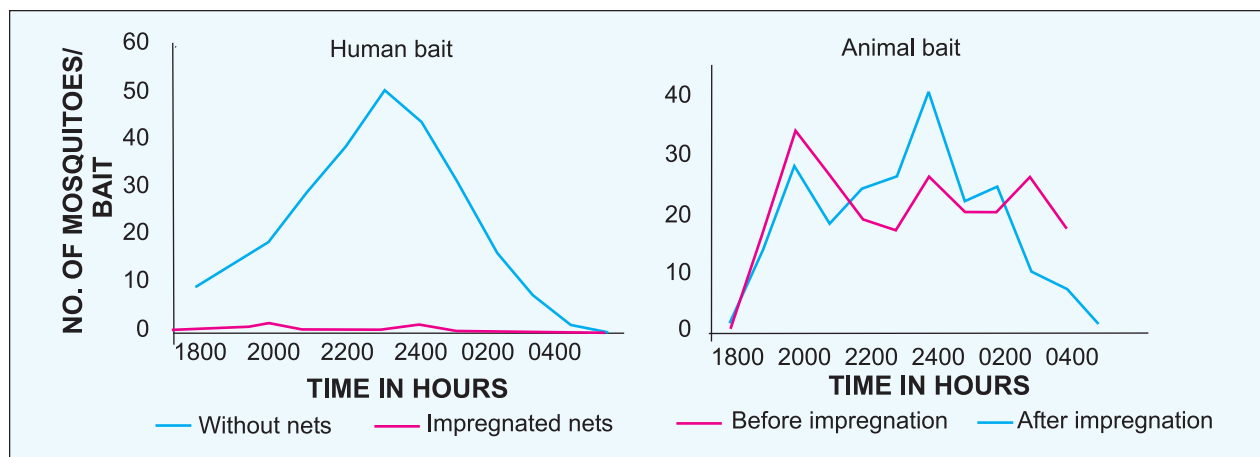


Fig. 3: Impact of cyfluthrin-treated bednets on biting of *An. sondaicus*

Table 2: Microfilaria rate in Nicobar district

Islands of Nicobar district	Population	Microfilaria rate %
Car Nicobar	19,252	7.00
Chowra	1,222	25.00
Teressa	1,777	13.79
Nancowry group	3,803	8.30
Katchal	5,066	3.60
Pillo-millo	90	0
Kondul	143	0
Campbell Bay	6,548	4.05

evaluated in the Nicobar group of Islands. The kit was evaluated on diurnally sub-periodic and nocturnally periodic forms of *W. bancrofti* infection among Nicobarese and settlers. The result obtained with the rapid test was excellent in comparison to the blood smear examination. The sensitivity of diagnosis was 100%. The ICT filariasis test has tremendous technical and practical advantages over microfilaria detection for routine surveys. The results are obtained quickly in the field. The new tool—the whole blood ICT filariasis test can play a major role for diagnosis of filariasis.

### Genetic variability of filarial parasite in Nicobari tribes

The genetic variability of the lymphatic filarial parasite *W. bancrofti* from five islands of Nicobar group of Islands, endemic for filariasis was studied using random amplified polymorphic DNA (RAPD) markers. The RAPD profiles were generated for 40 parasite popu-

lations. The phylogenetic analysis of profile by bio-numeric version revealed the presence of three genotypes of the parasites found in the Nicobar group of Islands. The microfilariae density and the disease pattern correlated with their genetic cluster. The finding of three genetic variants of diurnal sub-periodic *W. bancrofti* may have important implications in filariasis epidemiology and control programme.

### Sensitivity of *P. falciparum* to chloroquine

A study was conducted to determine the status of susceptibility of *P. falciparum* to chloroquine in Car Nicobar Island. Out of 66 patients selected for the study, seven showed resistance according to the standard WHO extended field test. Among them five showed RI level of resistance and one each showed RII and RIII level of resistance (Giri and Das, 1994).

### Studies on haemoglobinopathies and G-6-PD deficiency

A study on haemoglobinopathies and G-6-PD deficiency among Nicobarese tribal population was carried out and 98 Nicobarese were screened for thalassemia, 150 for G-6-PD and 220 persons for sickle-cell anaemia. Of them, 6 (5.88) were found to have Bit trait, 10 (6.66) were found to be G-6-PD deficient but no sickle-cell disease was observed.

### Larvivorous fish

An extensive fish fauna survey of Car Nicobar Island was carried out and 27 species were identified. *Ophiocara aporos*, *Megalops cypriniodes*, *Aplocheilus pan-*

*chax* and *Oreochromis mossambicus* were found to have considerably high larvivorous potential. A new larvivorous fish *Ophiocara aporos* was identified, and found to be the excellent larvivorous fish for the control of mosquito breeding in wells.

Large-scale production of *G. affinis* was achieved and 10 *G. affinis* hatcheries were established in Andaman (Port Blair) and Nicobar (Car Nicobar, Katchal, Nancowry and Campbell Bay) group of Islands. *G. affinis* were released in breeding habitats of *An. sundaicus* and proved very effective in the control of mosquito breeding. At Katchal Island, in addition to *G. affinis* hatchery, *O. melastigma* hatcheries were also established. Several fish hatcheries were set up all over the island.

### Colonisation of *An. sundaicus*

For the first time, *An. sundaicus* was colonised in 1992 (Das *et al.*, 2004). Cyclic colonies of fresh water forms and brackish water forms of *An. sundaicus* colonies were established. Natural biology of these vectors was investigated.

### Malaria clinic

To facilitate early and accurate diagnosis and prompt treatment of malaria, a malaria clinic was run. It provided excellent diagnosis and treatment facilities to patients. In addition, malaria cases were also diagnosed by rapid diagnostic test.

