40 Years of
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NIMR

Annual Report
2016–17

ICMR-National Institute of Malaria Research
(Indian Council of Medical Research)
Sector 8, Dwarka, New Delhi–110 077

भारतीय आयुर्विज्ञान अनुसंधान परिषद
INDIAN COUNCIL OF MEDICAL RESEARCH
NEW DELHI
नई दिल्ली

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Preface

I am pleased to present the Annual Report of the ICMR–National Institute of Malaria Research (NIMR) for the year 2016–17. The Institute has made steadfast progress in its research and development efforts and continued to fulfil its mandate of carrying out basic and applied research in addition to providing training and technical support to the National Vector Borne Disease Control Programme (NVBDCP), Govt. of India. During this period, the Institute took several major initiatives beside continuing some of the ongoing programmes. This report presents a snapshot of the year's key research activities, technical developments, scientific innovations, research support collaborations, academic and training programmes, institutional activities, community engagement initiatives, and the exceptional role and contribution of the Institute towards improving health outcomes related to malaria and other vector borne diseases.

The Institute continued to guide the drug policy of health care system on the basis of studies on therapeutic efficacy of antimalarials and is actively involved in Malaria Elimination Programme of the Government of Punjab and NVBDCP. A joint study conducted by NIMR, NIMS and NVBDCP has validated the disease burden estimates in India. A study carried out in Odisha demonstrated that improving access could decrease the burden of malaria. The Institute continued to support malaria control programme by providing training to different health personnel's, entomologists, district programme officers, consultants; and organized two WHO supported refresher courses.

Development of drug resistance in malaria parasites and insecticide resistance in vectors are major technical hurdles for the national malaria control programme. Several mutations have already been reported associated with drug resistance. Studies were continued to screen mutations in *kelch 13, dhfr* and *dhps* genes in order to understand the molecualr basis of drug resistance in malaria parasites for effective drug resistance management. The Institute also performed clinical trials of triple ACT and DHA piperaquine for management of drug resitance in malaria. Studies on safety of primaquine drug is underway. Beside drug resistance, insecticide resistance is also a major threat for the success of vector-borne disease control programme. This year NIMR identified a novel mutation in the insecticide target gene of *Aedes aegypti* which confers resistance against DDT and pyrethroids.

The research capabilities of the Institute were strengthened by creating world-class laboratories and involving international collaborations. The WHO Collaborating Centre for testing and evaluation of public health pesticides is being made GLP compliant. The NIMR is now a part of the Worldwide Insecticide Resistance Network. The WHO recognised lot testing laboratory continued to provide support to programme by ensuring the circulation of quality RDT in public health system. Bengaluru Field Unit developed insectary facility. External Competency Assessment was conducted for microscopists

from India for the first time. DST-ICMR Workshop on Climate Change Impact on Human Health, DHR Workshop on VBD Surveillance and various other training programmes were also organized. Research capacity was built at medical colleges by conducting ethics and research methodology workshops.

During the period under report, many scientists of the Institute were awarded for their achievements and contributions, from different organizations including ICMR. The scientifific workforce was strengthened by recruiting more numbers of scientists and graduate students under Masters and PhD programme. About 10 new scientists were recruited during the year for accelerating the productivity of the Institute. The services of most of the IDVC employees who were working as project worker were also regularized. The information, education and communication (IEC) activities were continued for creating mass awareness about malaria and dengue intervention measures. To encourage the progressive use of Hindi in official work, Hindi *Pakhwada* was celebrated with great zeal; cleanliness and hygiene-related activities under S*wachh Bharat Abhiyan* were also conducted on regular basis.

The Institute continued to publish the newsletters in Hindi (*Malaria Patrika*) and English (*Plasmodium*). Scientists published over 70 research papers in reputed journals. The *Journal of Vector Borne Diseases (JVBD)*, published by the NIMR continued to be one of the best journals of India, and achieved an Impact factor of 1.19 for the year 2016.

This Annual Report is a compendium of the activities and achievements of entire NIMR family. I thank all the scientists and staff of the NIMR for their sincere and dedicated efforts in making the Institute, a centre of excellence. Special thanks are due to all the collaborating partners for their support in undertaking different joint research projects to curb the major health issues across the country. Particularly, the inspiring guidance and constant support of the Secretary, Department of Health Research, Government of India and Director General of the Indian Council of Medical Research is much acknowledged. I am also grateful to the esteemed members of our Scientific Advisory Committee for their strategic motivation and directions through their insightful support.

Neena Valecha
Director

Executive Summary

Vector Biology and Control

- Entomological, parasitological and KAP studies in malaria epidemic prone Nuh CHC of District Mewat, Haryana suggested that *Anopheles culicifacies* sibling species A is playing a major role in malaria transmission in the study areas.
- An entomological survey in five malaria endemic districts of Punjab revealed prevalence of eight anopheline species involved in transmission of malaria.
- A comparative transcriptomic study of distinct feeding status in *An. culicifacies*, suggested that adult female mosquito olfactory system undergoes a limited, but unique change in their gene expression when switching feeding status from sugar to blood. A comprehensive transcriptional profiling in the mosquito *An. culicifacies* indicated that a coordinated transcriptional regulation of odorant binding proteins and odorant receptors exists to meet and manage complex host seeking and blood feeding behaviour
- A study identified and characterized the olfactory associated unique *quick-to-court* gene, which has sex-specific dual mode of actions to favour successful mating and blood feeding activities in the adult *An. culicifacies* mosquitoes.
- A study involving examination of gut-microbes relationship, unravelled that the dominant bacterial population load enriches till 24 hr in response to blood meal. Further, decoding the genetic basis of this relationship is expected to identify key genetic factors, that may have influence on *Plasmodium* development/ transmission in the mosquito *An. stephensi*.
- In a study, about 4.6 million Illumina sequencing reads were generated from 3-4 day old naïve adult female mosquito gut. This revealed a total of 6183 putative transcripts, and in initial species distribution analysis 4560 transcripts were of insect origin, while 682 transcripts showed significant homology to microbial origin, leaving 941 transcripts unmatched. Further, ongoing functional analysis will clarify that how gut-microbe interaction influences parasite development and transmission.
- Several *kdr* mutations have been reported in an Indian *Aedes aegypti* population, and a new mutation, F1534L was discovered which is associated with DDT and pyrethroid resistance. In addition a PCR-RFLP assay was developed to genotype *kdr*-allele F1534L and F1534C in *vgsc* gene of *Ae. aegypti*.
- A study was carried out to find out the breeding habit of *Ae. aegypti* in the Sahibabad area of Ghaziabad district. Survey suggested that desert coolers were the primary breeding containers. In *Jhuggis,* most preferred containers for *Aedes* breeding were cement tanks, drums, and small pots for storage.
- A study on efficacy of an innovative ovitraps in the Bagdola village, Delhi, showed that it is 90.1% more effective than conventional ovitraps made by using cellulose comb.
- An integrated vector management approach was attempted towards the reduction of dengue transmission in 24 lanes of Raj Nagar Part II, Najafgarh zone. Nearly 22,680 breeding containers in 3200 households were checked and controlled. Validation of GIS risk map was done with respect to dengue case map. It has been suggested to MCD to target households with multiple water storage containers in order to control cases in the area.

- In vector surveillance study for Zika/JE virus in Delhi and other cities, none of the 411 pools prepared out of 3104 individuals of *Ae. aegypti* mosquitoes were detected positive.
- In a follow up survey carried out in Keshkal block of Kondagaon district in southern Chhattisgarh, 91% malaria reduction was observed, as a result of LLIN intervention and high compliance rate.

Parasite Biology

- The extent of mutations in *Kelch13* gene in *Plasmodium falciparum* collected from four states of Northeastern region were analyzed for polymorphism associated with artemisinin resistance. A total of 12 mutations (eight non-synonymous and four synonymous) were observed and no key mutations (C580Y, R539T, I543T and Y493H) associated with artemisinin resistance were detected.
- To explore the feasibility of *Plasmodium* IspE as a drug target, the *IspE* gene from *P. vivax* (*Pv*IspE) was investigated. The observed kinetic parameters of *Pv*IspE recombinant protein strengthen the candidature of *Plasmodium* IspE as a novel drug target and set a firm base for structure-based drug designing approaches paving the way for the therapeutic exploitation of *Plasmodium* IspE inhibitors for the effective treatment of malaria.
- Docking and modelling studies of *P. falciparum phosphoethanolamine methyltransferase (Pfpmt)* gene lead to selection of five out of 500 Asinex compounds, which showed good interaction with target protein and formed hydrogen bonds with crucial conserved amino acids for transmethylation as well as inhibition (IC_{50} < 5µM) on *P. falciparum* culture. Thus, these five hits may act as common inhibitors for both *Pfpmt, Pvpmt* and other *Plasmodium* orthologs worldwide.
- A study was carried out to identify the molecular marker(s) for relapse malaria in the *P. vivax*. PCR-RFLP of *PvMSP3α* gene performed on the blood samples collected from Delhi and Haryana showed that its highly polymorphic in nature, which in turn can be used in differentiation between relapse and reinfection of vivax malaria.

Epidemiology

- Comprehensive Case Management Programme (CCMP) has led to a significant increase in access to diagnosis and treatment in different transmission settings in the state of Odisha. CCMP approach is showing increase in malaria cases due to improved surveillance followed by decline due to interventions.
- NIMR is actively participating towards malaria elimination programme. A MoU was signed between Government of Punjab and NIMR regarding malaria elimination in the Punjab state. A malaria clinic was made operational at Dhakoli, Punjab that caters to the patients reported at the Dhakoli CHC.
- Health Impact Assessment of entire Narmada Basin Dams was further extended into Phase-III. Under this project entomological, parasitological and microbiological (water quality) studies were undertaken in the 20 affected dams of Narmada Basin and mitigation measures were suggested to NVDA and the State Health Department.
- A study generated risk maps for malaria from the viewpoint of malaria prevalence, climatic determinants and suitability, climate change, malaria vector's distribution and ecological risk in India with emphasis on creating layers for forest, NDVI, soil, slope and altitude maps, so as to generate a composite risk map of malaria. The map based on climatic parameters projected that by the year 2030, many foci will show reduction in transmission intensity against the baseline year of 2008. In contrast, a few new foci are expected in Himalayan states like Uttarakhand and Himachal Pradesh.

Clinical Research

- Therapeutic efficacy of ACT was monitored in Antagarh CHC, Kanker district, Chhattisgarh. The study indicated that response of 3-dose regimen of ACT (AS + SP) is effective in clearing the asexual parasitaemia in 100% of patients within three days.
- Therapeutic efficacy studies of ACT were conducted at 15 study sites selected in consultation with the NVBDCP. The data generated showed that the prescribed anti-malarial ACT (AS + SP and AL) in *P. falciparum* and chloroquine in *P. vivax* malaria patients by

the national programme are effective and safe.

- A multicentre, phase-IIIb, single arm trial was carried out at Ranchi and Mangalore. It was aimed to assess the safety, tolerability and efficacy of Eurartesim oral film-coated tablet formulation (160/20 mg or 320/40 mg PQP/DHA) in children and adolescent patients with acute uncomplicated *P. falciparum* malaria.
- A total of 240 patients were enrolled for an open-label randomized trial to compare the standard ACT treatment with that of triple artemisinin-based combination therapies (TACTs), for evaluating the efficacy, safety, tolerability of artemisinin and partner drug in Odisha, West Bengal and Tripura.
- A study investigated the drop of haemoglobin and recovery following 14-day primaquine treatment for *P. vivax* radical cure in Odisha. No haemolytic symptoms were observed in enrolled patients with maximum fall in mean Hb by Day 3, which recovered by Day 42. Preliminary analysis indicates that primaquine causes haemolytic anaemia in a fraction of patients.
- The fever clinic at NIMR diagnosed 103 malaria cases, out of which 99 were *P. vivax* and four were *P. falciparum* cases. The peak in malaria cases was seen in the month of August and September 2016. As one of the sentinel surveillance site for diagnosis of dengue and chikungunya, a total of 770 dengue cases and 1753 chikungunya cases were also diagnosed in 2016 with maximum number of cases observed in the month of September 2016. ❑

Main Building of the Institute (NIMR)

Staff of the Institute (NIMR)

Vector Biology and Control

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1.1 Vector Biology

1.1.1 Entomological, parasitological and KAP studies in epidemic prone Nuh CHC of District Mewat, Haryana

Entomological, parasitological and KAP studies were continued during 2016 which confirmed the observations made during the previous year. Seasonal abundance of *Anopheles culicifacies* and *An. stephensi* showed variation, and peak densities of vectors were observed during monsoon months which correlated well with the average monthly rainfall data. Though, both vectors were found primarily zoophagic, the Human Blood Index of *An. culicifacies* (HBI = 0.17) was significantly higher than that of *An. stephensi* (HBI = 0.02). Analysis of sibling species composition of *An. culicifacies* population showed that it mostly comprised of species A (>98%) which is an efficient malaria vector. *Anopheles culicifacies* was incriminated for *Pv* and *Pf* CS antigen during the monsoon season similar to the previous year; however, no *An. stephensi* species was detected harbouring sporozoites (Table 1). These observations suggest that *An. culicifacies* is playing a major role in malaria transmission in the study area. Active surveillance in study villages during transmission season (August–September 2016), revealed average slide positivity rate of 28.8. Though, *Plasmodium vivax* cases predominated there was substantial increase in proportion of *P. falciparum* cases (Table 2).

Table 1. Incrimination of *An. culicifacies* and *An. stephensi* in study villages by ELISA

Species	Year	Total tested	Total +ve	*Pf*	*Pv* 210	*Pv* 247
An. culicifacies	2015	435	1	–	–	1
	2016	307	1	1	–	–
	Total	742	2	1	–	1
An. stephensi	2015	359	0	–	–	–
	2016	166	0	–	–	–
	Total	525	0	–	–	–

A questionnaire-based household survey to generate information on socio-economic status, awareness about malaria, personal protection practices and health seeking behaviour *etc.* of the inhabitants of study villages was completed. Statistical analyses of data using IBM SPSS revealed that apart from low income and poor educational status of the community, inadequate knowledge of malaria, insufficient usage of personal protection measures, health seeking behaviour due to poor health care facilities at village level, poor perception of the community about IRS operation were the major factors influencing malaria transmission.

Table 2. Results of active surveillance in study villages of PHC Ujina during transmission season (August-September 2016)

Village	Total tested	*Pv*	*Pf*	Mix (*Pv*+*Pf*)	Total +ve	SPR
Chilawali	39	10	2	–	12	30.76
K.C. Pur	40	3	5	–	8	20
Gundwas	17	4	4	–	8	47.05
Jaisingh Pur	22	3	3	–	6	27.28
Total	118	20	14	–	34	28.8

Based on the information generated on above mentioned parameters, the potential risk factors in malaria transmission were delineated. In addition, evidence-based suitable antivector, antiparasitic measures and additional efforts required on part of state health department in curbing malaria transmission were suggested. Implementation of the suggested vector/malaria control measures would reduce the transmission level and prevent epidemic like situation in the study area.

1.1.2 Entomological survey in five malaria endemic districts of Punjab

Mosquito collections were carried out in five districts of Punjab in the morning hours to

know the anopheline fauna and vector density and their susceptibility to DDT, malathion and deltamethrin. *Anopheles culicifacies* was found 100% susceptible to malathion [currently being used for indoor residual spray (IRS) in Punjab]. *Anopheles stephensi* was available in high density in Mansa, Bathinda and Ludhiana districts and showed 55–63% mortality against DDT, 90–95% mortality against malathion and 97–100% mortality against deltamethrin (Table 3).

During entomological surveys, eight anopheline species were recorded from the five districts (Table 4). The density of primary malaria vector, *An. culicifacies* was 11.8 in SAS Nagar; however, it was comparatively lower in other four districts.

Table 3. Insecticide susceptibility status of vector species in five districts of Punjab

Districts	Vector species	% corrected mortality against		
		DDT	Malathion	Deltamethrin
SAS Nagar (Mohali)	*An. culicifacies*	–	100	–
Mansa	*An. stephensi*	62.5	95	100
Bathinda	*An. stephensi*	55	92.5	100
Ludhiana	*An. stephensi*	60	90	96.7

Table 4. Man hour density of anopheline species in five districts of Punjab

S.No.	Species	Mohali	Patiala	Mansa	Bathinda	Ludhiana
1.	*An. culicifacies*	11.8	0	3.3	2.9	0.3
2.	*An. stephensi*	1	0	24	30.5	13.8
3.	*An. annularis*	5	11.25	9.7	0	0.3
4.	*An. subpictus*	46.5	22.6	5.3	1.4	0
5.	*An. vagus*	56.7	44.75	0	0.9	0
6.	*An. nigerrimus*	0	0	0	0	0.7
7.	*An. acconitus*	0	0	2.7	0	0
8.	*An. pulcherimus*	0	0	0	0.1	0

Strikingly, the density of *An. stephensi* was quite high in Mansa, Bathinda and Ludhiana districts in comparison to SAS Nagar and Patiala. The density of secondary vector *An. annularis* was high in SAS Nagar, Patiala and Mansa, whereas it was absent in Bathinda and very low in Ludhiana districts.

The 710 vector mosquitoes were (*An. culicifacies*, *An. stephensi* and *An. annularis*) collected during the surveys and assayed for detection of sporozoite, where none was found positive.

1.1.3 Unravelling molecular complexity of mating and blood feeding behaviour in *An. culicifacies* mosquito

Mating and feeding in insects are two mutually exclusive events. But, both of these behaviours are interdependent with respect to life cycle maintenance and are centrally regulated by the olfactory system of mosquitoes. Thus, one of the key molecular strategies for controlling mosquito population is hidden in the exploration of the path of mosquito's odour detection. The odour detecting organs consist of highly sensitive antennae which are covered with fine scenting hairs called sensilla, which can pick up passing-by odour molecules. Female mosquitoes have a particular taste for protein rich human blood, because it is vital to help mosquito eggs maturation and provides them with nutrients. Olfactory receptors (ORs) present on the membrane of the OR neurons of the sensilla, are the key acceptor moiety that bind with the odour molecules which are transported by odorant binding proteins (OBPs). After binding with the receptor molecule the downstream signal transduction procedure starts. Furthering the previous understanding of the complexity, about how mosquito's olfactory system manages complex events of host seeking and blood feeding, the present study extensively profiled the transcription of selected transcripts, recently identified from the ongoing RNAseq analysis, under distinct feeding status.

To uncover the OBP relationship, the transcriptional profiling of the few selected OBP genes was studied in *An. culicifacies* according to the Zeitgeber time scale. The circadian clock dependent analysis of the OBP genes indicated the midnight high biting behaviour of *An. culicifacies* mosquito (Fig. 1). Further, to uncover the ORs complexity and their respective functions, pre-catalogued OR genes were analyzed. It indicated that naïve mosquitoes expressed a fairly large number of receptor genes whereas, a distinct repertoire of receptor genes of different composition uniquely appeared in the

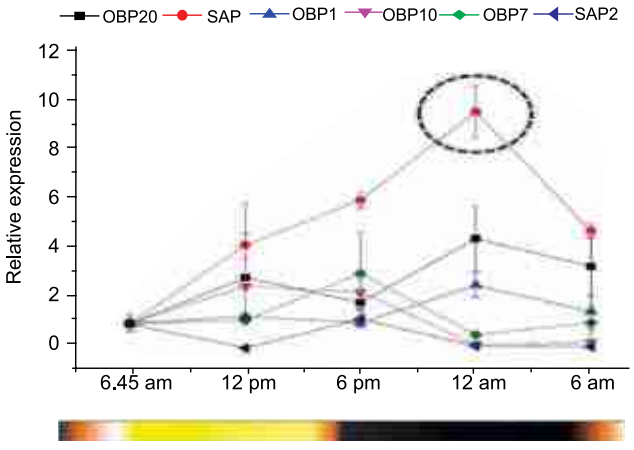


Fig. 1: Modulation of mosquito olfactory OBPs in response to circadian clock.

blood fed cohorts, though their number was much lower than the naïve mosquito. To explore the possible role of this class of receptor proteins, age and time dependent transcriptional behaviour of selected transcripts were monitored in response to two consecutive blood meal series follow-up.

Interestingly, an age dependent enrichment was observed till 6th day of maturation in the naïve mosquitoes, suggesting that naïve mosquito might express and attain a full spectrum of chemosensory genes expression to meet all the needs of their life cycle requirements, *i*.e. host seeking and mate finding behavioural response. First blood meal to the 6th day old naïve mosquitoes, transiently down-regulated the expression of almost all the transcripts within 30 min of blood feeding, whose expression further depleted till 30 hr post blood meal, except the slight up-regulation of two transcripts OR42 and OR62, to meet an expression level of abundance equal to 3–4 days old naïve mosquitoes (Fig. 2). Together, these data provide evidence that olfactory

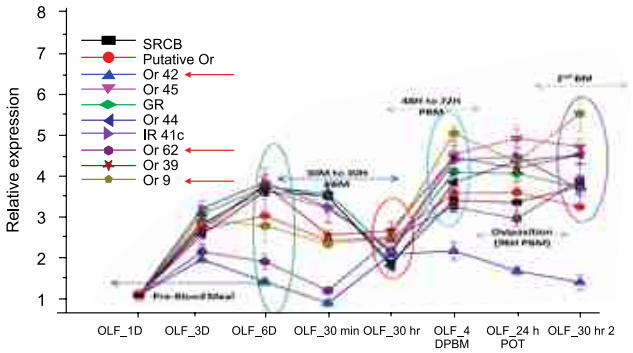


Fig. 2: Age dependent and blood meal response of mosquito olfactory receptors.

encoded factors have significant influence on the host-seeking and blood feeding behaviour in mosquito. Uncovering this genetic relationship could facilitate in designing a strategy to interrupt mosquito-human bite exposure.

1.1.4 Quick-to-court protein, unique to manage mating and blood feeding behaviour of *An. culicifacies*

Compared to female mosquito, male mosquito indirectly contributes to disease transmission by inducing several post-mating behavioural changes in females, including the induction of blood feeding behaviour. Thus, males maintain the continuity of the mosquito life cycle. The complex mating behavior of mosquitoes consist of the sequential events of swarm formation, suitable mate finding and successful aerial coupling, which are tightly regulated by genetic and non-genetic factors. To uncover the genetic relationship, a 383bp (Accession #KX575650) long unique transcript encoding the '*quick to court*' (qtc) protein was identified from the olfactory system of the blood-fed adult female mosquito for analysis. It is a homolog of *Drosophila* coiled-coil QTC (Q9VMU5) protein and has been shown to play an important role in driving the male courtship behaviour.

The detailed *in silico* analysis of 1536 bp long full-length *qtc* transcript (ACUA027268) revealed that it is comprised of a 50 bp 5′ UTR region followed by five exons and four introns followed by a 50 bp 3′UTR region as shown in (Fig. 3a). Tissue-specific transcriptional profiling of *Ac-qtc* in the naive mosquitoes revealed high olfactory abundance of *Ac-qtc* gene in both the sexes of mosquitoes (Fig. 3b). Age dependent transcriptional regulation of *Ac-qtc* in virgin male and female mosquitoes showed the ascending pattern of *Ac-qtc* expression till 5th day, irrespective of the mosquito sexes (Figs. 4a and b). After reaching a threshold on 5th day it started to down regulate till 7th day. Interestingly, after 7th-day *Ac-qtc* expression switched to up-regulation again in male mosquitoes. Available literature suggests that in most *Anopheline* mosquitoes, the mating behavioural activities commenced by the onset of sunset, usually at 1700 hr which may continue till 2000 hr. The present observations indicated that once male mosquitoes achieved the specific age of adulthood, the natural dysregulation of *Ac-qtc* by unknown mechanism might promote the courtship behaviour.

It may be hypothesized that the transcriptional modulation of *Ac-qtc* in response to dawn/dusk cycle must have a functional correlation with the

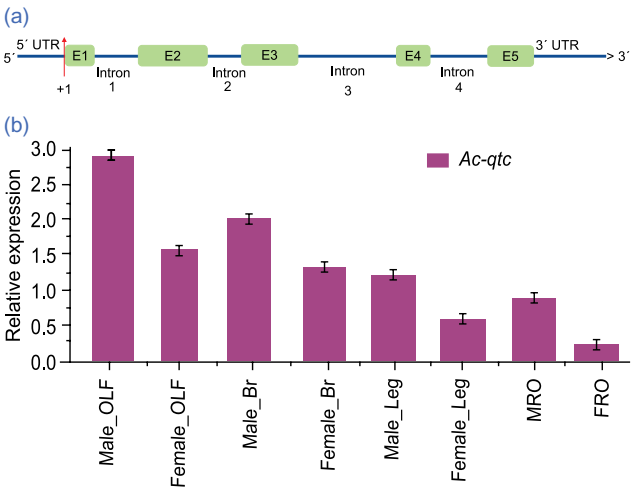


Fig. 3: (a) Schematic overview of genomic organization of *Ac-qtc;* and (b) Tissue specific relative gene expression analysis of *Ac-qtc* in the adult male and female mosquitoes.

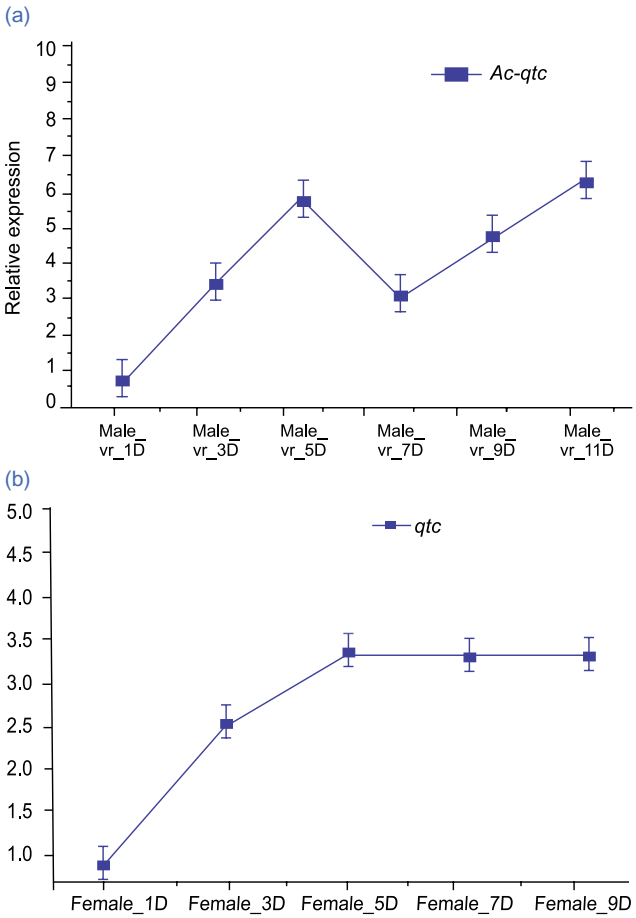


Fig. 4: Sex-specific age dependent expression of *Ac-qtc* in the olfactory system of (a) Virgin adult male; and (b) Adult female; mosquitoes.

mating success (Fig. 5). To test this, two sperm-specific transcripts were identified from the draft genome of *An. culicifacies*, using *ams* and *mts* as query sequences, previously characterized from *An. gambiae*. When compared to the virgin counterpart, significant down-regulation of *Ac-qtc* was observed in the olfactory system in both the sexes at 1900 hr, which indicated that lower expression *Ac-qtc* may favour the increased mating frequency and active courtship engagement (Fig. 6a). A significant modulation of *Ac-ams*/*Ac-mts* expression was observed in the mated female spermathecae; moreover, male reproductive organs supported the idea that a natural dysregulation of *Ac-qtc* in the late evening, *i.e.* 1900 hr may favour the copulation process by facilitating the release of unknown sex driving factors for successful insemination in the copulating couples (Fig. 6b). This study provides the first molecular evidence that *Ac-qtc* proteins may have dual mode of action in the regulation of cluster of mosquito olfactory genes that are linked to mating success and/or blood feeding in adult female mosquitoes.

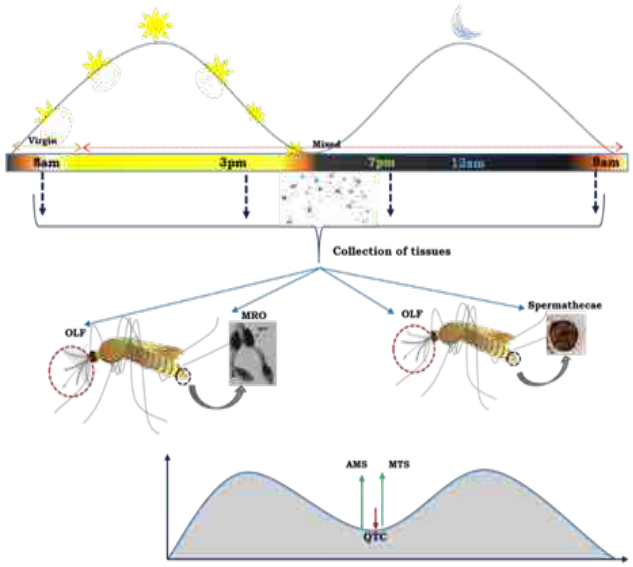


Fig. 5: Hypothesis to test the role of *Ac-qtc* in courtship behaviour of mosquitoes.

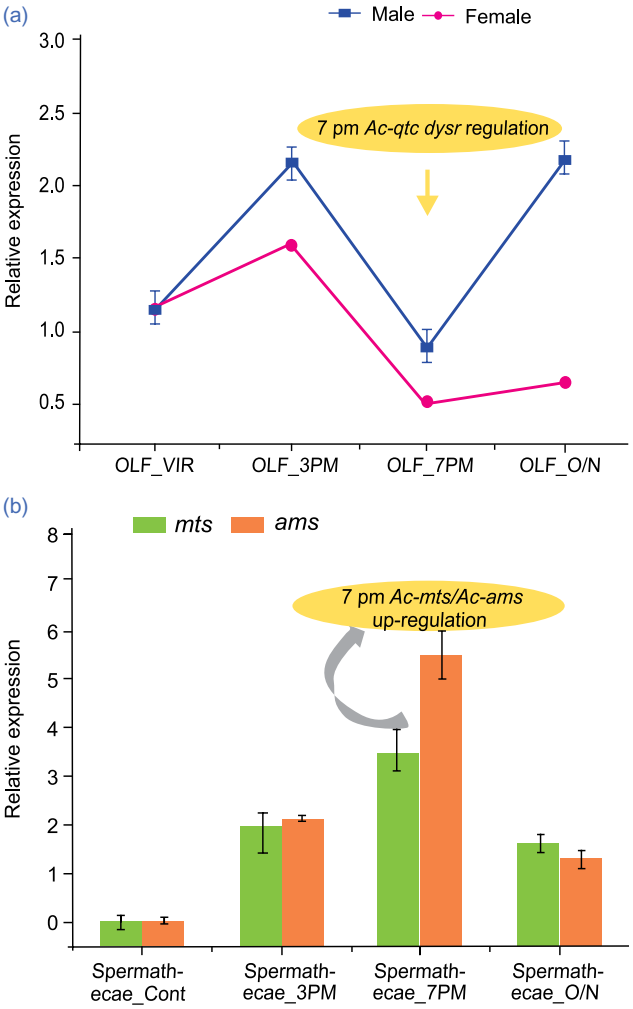


Fig.6: (a) Molecular evidence of active courtship engagement induced natural dysregulation of *Ac-qtc* in the olfactory system of both sexes; and (b) Up-regulation of sperm-specific transcripts (mts/ams) in the spermathecae of adult female mosquitoes, in late evening.

1.1.5 Uncovering molecular relationship of gut-microbiome interaction in *An. stephensi*

The insect's gut is believed to be an important interface which not only provides a compatible physiological environment, space and battery of digestive enzymes/proteins to digest diverse nutrients, but also supports the growth of gut-associated microbial flora as well pathogen development. Recently, gut-associated bacterial endosymbionts in blood feeding insects have also been shown to play multiple key roles in blood meal digestion, metabolism, reproduction and fighting pathogens.

Emerging field trials data of *Wolbachia* mediated antiviral (dengue) effect on the *Aedes* mosquito have shown promising results in suppressing the dengue fever cases in China, Brazil, Australia *etc.*, encouraging the designing and implementation of similar effective molecular strategies for anti-plasmodial responses in the Anopheline mosquito to combat malaria. However, unlike *Aedes* mosquito, the establishment and stability of *Wolbachia* infection in Anopheline mosquito host remains challenging. Alternatively, identifying and characterizing antiparasitic potential of key gut-endosymbionts could be helpful in establishing complementary 'paratransgenesis' strategy for Anopheline mosquitoes. Though many international laboratories are trying to understand the gut microbiome community structure to identify the key bacteria such as *Elizabethkingia*, *Serratia* and *Asaia*, the molecular nature of complex interactions between molecular factors of gut origin and gut-associated bacteria, regulating gut physiology and functions remains unexplored. Hence, comprehensive meta-transcriptomic studies were initiated to untangle and identify molecular factors of mosquito/bacteria influencing gut-microbe interaction, in the laboratory reared *An. stephensi* mosquito.

An ongoing gut-metagenomic analysis of ~0.36 million Illumina sequencing reads generated from 3–4 days old naïve adult female *An. stephensi* mosquito revealed that Bacteroidetes and Proteobacteria are the most abundant phylums marking Flavobacteria and Gammaproteobacteria as most significant classes respectively (Fig. 7). The metagenomic data analysis highlighted the presence of *Elizabethkingia* (73.13%) and *Pseudomonas* (13.25%); *Eubacterium* (2.26%) and *Treponema* (1.22%), at the genus level (Table 5). The relative

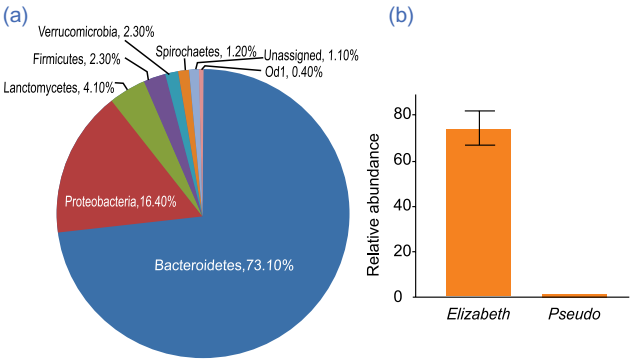


Fig. 7: (a) Gut-associated microbial community structure: Identified bacteria are classified at Phylum level; and (b) Relative abundance of *Elizabethkingia* and *Pseudomonas* in the naïve mosquito midgut.

Table 5. Relative abundance of bacteria classified at Genus level

Taxonomy (Genus)	Abundance
Elizabethkingia	73.13
Pseudomonas	13.25
Eubacterium	2.26
Treponema	1.22

expression by real-time PCR also showed an abundancy of *Elizabethkingia* and *Pseudomonas* in the sugar-fed mosquito midgut, corroborating the metagenomics data.

In fact, *Elizabethkingia meningoseptica* is a genus of aerobic, non-motile, Gram-negative rods that is ubiquitous in nature and members of this genus thrive in wet habitats and hospital settings, in particular water supplies and saline flushing solutions. Studies have shown that endosymbiotic bacterial species in the *Anopheles* mosquito gut are potent modulators of sexual development of the malaria parasite, *Plasmodium*, and thus proposed as potential control agents of malaria transmission. A time dependent blood meal response revealed that *Elizabethkingia* gains population enrichment at 18 to 24 hr post-blood meal, coinciding with crucial timing of *Plasmodium* ookinetes invasion and traversing the mosquito gut (Fig. 8). Profiling of the bacterial load in response to *Plasmodium* infection

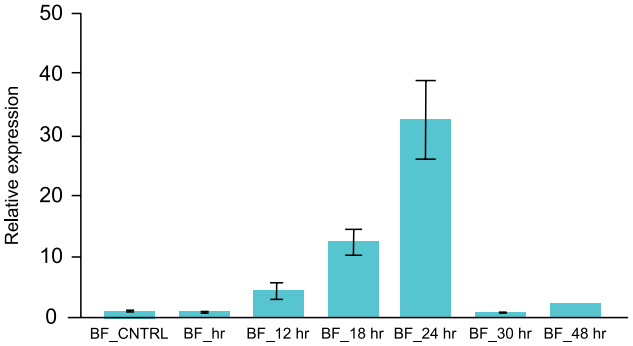


Fig. 8: Relative abundance of *Elizabethkingia* in response to blood meal.

may further unveil the important species-specific microbe-parasite interaction strategies.

1.1.6 RNAseq analysis predicts molecular relation of gut-microbe association

To understand the molecular complexity of the mosquito gut, a total of 6183 putative transcripts were generated from 4.6 million Illumina sequencing reads, derived from 3-4 day old naïve adult female mosquito gut. Interestingly, an initial species distribution analysis revealed 4560 transcripts of insect origin, while 682 transcripts showed significant homology to microbial origin, leaving 941 transcripts unmatched. Transcripts of insect species dominantly matched to Anopheline (94%), *Aedes* (2%), *Culex* (1%), *Drosophilla* (1%) and other insects (2%). Whereas, microbial origin genes dominantly matched to *Elizabethkingia* (57%) and *Annacalia* (31%) genus (Fig. 9). A comprehensive understanding of transcriptional responses against *Plasmodium* infection and

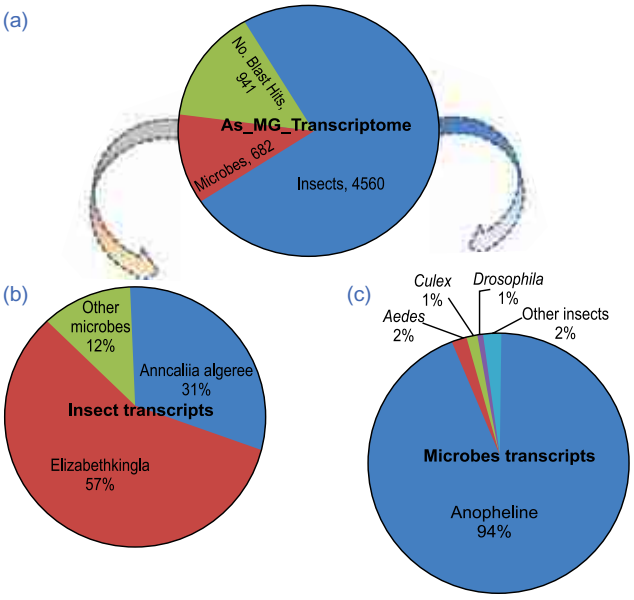


Fig. 9: (a) Pie chart showing the species distribution analysis of the naïve sugar-fed midgut of *An. stephensi* mosquito; (b) Field vision of microbes related transcripts; and (c) Field vision of insect related transcripts.

functional analysis of selected mosquito-microbe putative transcripts might be helpful in clarifying, how gut-microbe interaction influences parasite development and transmission.

1.1.7 Multiple knockdown resistance (kdr) mutations in *Ae. aegypti* with report of a new kdr mutation F1534L associated with insecticide resistance

Aedes aegypti, a main vector of dengue, yellow fever, chikungunya and Zika viral infections has attained global importance due to its progressive invasion in different parts of the world. Unfortunately, there is no specific treatment or vaccine available to control these arboviral infections, and therefore, vector control remains the only option to control these infections. One of the potential methods for the control of this vector is the use of pyrethroid group of insecticides recommended by the WHO for space spray and personal protection measure. Understanding the mechanisms of insecticide resistance in vector populations is crucial for its effective management. One of the mechanisms of insecticide resistance in mosquitoes against pyrethroids and DDT is knockdown resistance (kdr), which is conferred by alteration in the target site of action, *i.e.* the voltage-gated sodium channel (VGSC) resulting from non-synonymous mutations. Several kdr mutations have been reported in *Ae. aegypti* from different parts of the world, amongst which, mutations at three loci, *i.e.* Iso1011 (I→M/V) and Val1016 (V→G/I) in domain II and F1534 (F→C) in domain III are most commonly reported and have been shown to confer pyrethroid resistance. The presence of multiple kdr mutations was reported through this study in an Indian *Aedes* population, with discovery of new mutation F1534L which is associated with DDT and pyrethroid resistance.

Two to four days old sugar-fed adult *Ae. aegypti* female mosquitoes (F_0 and F_1) were exposed to 0.05% deltamethrin, 0.75% permethrin and 4% DDT-impregnated papers (supplied by the WHO Collaborative Centre for Vector Control Research, Universiti Sains, Malaysia) for one hour following WHO's standard insecticide susceptibility test guidelines and were transferred to recovery tubes following exposure. Mortalities were recorded after 24 hr of recovery period and individual mosquitoes were stored at –20°C for DNA isolation. All bioassays were carried out at 25 ± 1°C and RH 60–70%. DNA was isolated from individual mosquitoes after removing 1/3rd of the posterior abdomen, carrying spermatheca, following the method described by Livak *et al* (1994) and stored at 4°C. Permethrin-resistant mosquitoes (F_2 generation maintained in insectary which survived exposure to 0.75% permethrin for 1 hr) were sequenced for domain II and III of the VGSC.

It was not possible to identify the correct amino acid codon through DNA sequencing in samples which were found heterozygous for two nucleotide positions, *i.e.* first and second codon of the F1534 residue. Hence, five such heterozygous

samples were cloned and sequenced to identify the correct codon. Samples were PCR-amplified using primers AekdrF and AekdrR following Kushwah *et al* (2015). The amplified product was cloned in pGemT Easy Vector Systems (Promega Corporation) as per manufacturer's protocol and sequenced using universal primers SP6 and T7.

DNA sequencing of partial domain II of the VGSC revealed presence of two mutations; S989P resulting from T>C substitution (TCC→CCC) on first codon, and V1016G due to T>G substitution (GTA→GGA) at second codon. Out of the total 67 samples (sequenced successfully from both directions), 46 were homozygous wild for both residues, *i.e.* SS at residue S989 and VV at residue V1016, 16 were heterozygous (SP and VG) and five were mutant homozygous (PP and GG). It was observed that S989 was linked to V1016 and 989P was linked to 1016G.

DNA sequencing of permethrin-resistant samples for partial domain III of the VGSC revealed presence of two non-synonymous mutations at residue F1534 (TTC), *i.e.* T>C substitution on the first position of the codon, leading to Phe→Leu (CTC) mutation, and T>G substitution on the second position of the codon leading to Phe→Cys (TGC) mutation. Of the 27 sequenced samples, one was homozygous FF (TTC, wild), seven were homozygous for CC (TGC), four were homozygous for LL (CTC), and four samples were heterozygotes for each of FC and FL and seven YKC which could be either heterozygote for LC (CTC+TGC) or FR (TTC+CGC). The latter combination was ruled out as successful sequencing of 15 cloned PCR products from five such samples revealed presence of CTC or TGC codon only. Further, all the seven heterozygote samples with the sequence YKC were cleaved when digested with restriction enzyme *Eco88*I indicating the presence of 1534L in all the samples further confirming the presence of a CTC+TGC codon combination in all seven samples.

1.1.8 New PCR-RFLP-based assay for the identification of all kdr mutations present in domain III of voltage-gated sodium channel in *Ae. aegypti*

In earlier studies a PCR-RFLP for genotyping T1520I and F1534C has been reported, where PCR product amplified using primers *A*ekdrF and *A*ekdrR were subjected to digestion with restriction enzymes *BsaB*I and *Ssi*I, respectively. Search for F1534L-specific restriction enzyme site was performed using an online tool available at *http://insilico.ehu.es/restriction/two_seq*, which revealed the presence of a unique restriction site *Eco88*I in the sequence. For genotyping of all *kdr* alleles present in domain III, PCR-RFLP method developed by Kushwah *et al* was modified. In the modified procedure, additional RE digestion was performed in a separate tube including *Eco88*I in addition to *BsaB*I and *Ssi*I. Additional restriction enzyme reaction mixture (20 µl) contained 5 µl of PCR-amplified product, 2 units of *Eco88*I enzyme and 1x buffer. This was incubated for 4 hr or overnight at 37°C, subsequently electrophoresed on 2% agarose gel and visualized on gel documentation system. The criteria for scoring of F1534 alleles were modified which are presented in Table 6, while the criterion for scoring of T1520 alleles remains unchanged. The gel photograph showing result of PCR is shown in Fig. 10.

Table 6. Criteria for scoring of F1534-alleles in PCR-RFLP assays

Species	Size of PCR-RFLP bands in	
	*Eco88*I-RFLP	*Ssi*I-RFLP
FF	171	171
FC	171	171, 103 and 68
FL	171, 103 and 68	171
CC	171	103 and 68
CL	171, 103 and 68	171, 103 and 68
LL	103 and 68	171

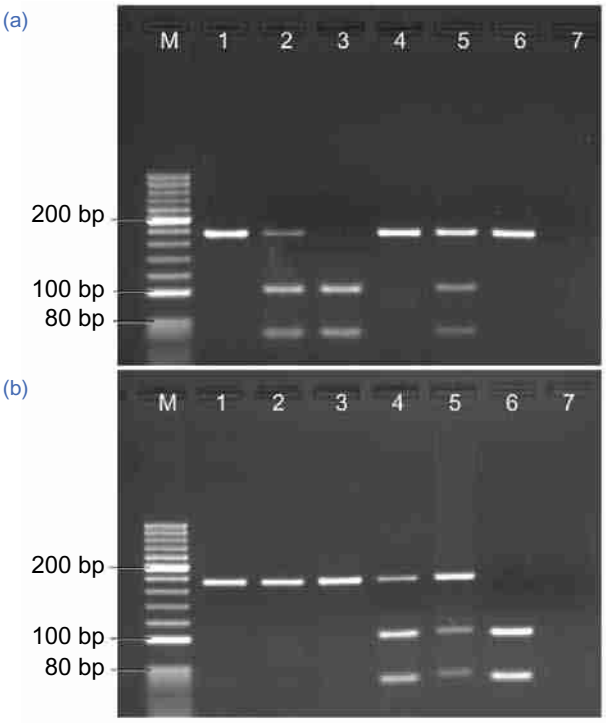


Fig.10: Gel photographs of (a) *Ssi*I- and (b) *Eco88*I-PCR-RFLP digests showing banding pattern of the different F1534-kdr genotypes. Lane M corresponds to 20 bp ladder; Lanes 1 to 6 corresponds to genotypes FF, FC, CC, FL, LC and LL, respectively; and Lane 7 is negative control.

Results of genotyping of alleles at locus F1534 on field collected F_0 populations showed that the frequency of F1534C and F1534L varied from 41–59 and 10–35% respectively in different collections carried out in the years 2014 and 2015. The T1520I was completely absent in this population.

The distribution of various F1534-*kdr* alleles in dead and alive mosquitoes (F_0 and F_1) after exposure to 0.75% permethrin (type I pyrethroid), 0.05% deltamethrin (type II pyrethroid) and 4% DDT and genetic association of *kdr* alleles with resistance phenotype. It was observed that 1534L showed strong protection against permethrin ($p < 0.0001$), moderate protection against deltamethrin ($p > 0.01$), but did not showed protection against DDT. Other allele 1534C showed strong protection against permethrin ($p < 0.0001$), low protection against DDT ($p < 0.5$) and deltamethrin.

1.1.9 *Aedes aegypti* larval indices in the Sahibabad area of Ghaziabad district

This study was initiated in the month of July 2016 in the Sahibabad area of Ghaziabad district. A total of 667 houses in seven localities were searched for *Ae. aegypti* breeding in all kind of water holding receptacles kept both indoors and outdoors (open space inside the house) of which 405 were found positive, resulting in the House index 60.71%. Similarly, a total of 999 containers were searched for *Aedes* breeding and 355 were found positive, thereby giving the container index 35.53 and Breteau index 53.22 (Table 7). The most preferred containers for *Aedes* breeding were cement tanks, drums, and small pots for storage of water mostly in *Jhuggis*. *Aedes* breeding was found to be maximum in desert coolers which were the primary breeding containers found during the survey. The positive containers were emptied out/destroyed with the help of local community.

Table 7. *Aedes aegypti* larval indices in Indrapuram, Ghaziabad from July to October 2016

Localities	Total houses searched	+ve houses	House index	Containers searched	+ve containers	Container index	Breteau index
Nyay Khand	369	272	73.71	454	126	27.75	34.14
Sector-6	156	23	14.74	95	29	30.52	18.58
Jhuggis Sector-5, 6 & 8	142	110	77.46	450	200	44.44	140.84
Total	667	405	60.71	999	355	35.53	53.22

1.2 Vector Control

1.2.1 Large-scale (Phase III) evaluation of efficacy, fabric integrity and community acceptability of Olyset Plus long-lasting insecticidal nets compared with Olyset net in India

Olyset Plus LLIN is made of 150 denier high-density mono-filament polyethylene yarn containing 2% permethrin (w/w) corresponding to 20 g AI/kg (about 800 mg of AI/m^2) and piperonyl butoxide (PBO) 1% (w/w), as synergist, corresponding to 10 g PBO/kg (about 400 mg of PBO/m^2) which is incorporated in all the fibres on all sides and also on the roof. Permethrin and the synergist migrate through the net by diffusion at a constant ratio of 2:1, thus ensuring enhanced efficacy against mosquitoes. The rate at which permethrin and PBO migrate to the surface of the net is adjusted to provide rapid regeneration, making the net active again within 1–2 days after washing. Olyset is a 100% high density polyethylene, 150 denier net, blended with permethrin 2% (w/w) as active ingredient, corresponding to 20 g/kg ± 25% (15–25 g/kg). A total of 1824 (Olyset plus–895; Olyset–929) nets were randomly distributed during August–September 2014 in 10 villages of Kanker (6) and Balod (4) districts after obtaining written informed consent from all households to participate in the trial. An adverse effect assessment survey was carried out in 100 houses after one month of net distribution in each study arm. It revealed transient nature of adverse effects which did not require medical treatment. Most of the complaints were related to bad smell. Thirty Olyset Plus and Olyset Nets sampled at the baseline and those withdrawn after 6 and 12 months of distribution fulfilled the WHO criteria of ≥95% knockdown or ≥80% mortality in cone bioassays when tested against susceptible *An. culicifacies*. Out of 30 Olyset Plus nets withdrawn after 18 months, eight failed in cone bioassays, whereas all 30 Olyset nets passed. All failed nets when subjected to tunnel tests, met the efficacy criteria of ≥80% mortality and ≥90% blood-feeding inhibition. In control tunnel tests with untreated netting piece, the blood-feeding rate was >50% while mortality was <10%. Out of 30 Olyset Plus nets withdrawn after 24 months, 23 failed in cone bioassays, whereas all 30 Olyset nets failed. All failed nets when subjected to tunnel tests, met the efficacy criteria of ≥80% mortality and ≥90% blood-feeding inhibition. Cone bioassays of each of the

30 Olyset Plus and Olyset Nets withdrawn after 30 months is in progress. Nets withdrawn from villages for efficacy monitoring at an interval of 6, 12, 18, 24 and 30 months were replaced with new nets of the same brand.

Surveys of cohort nets for fabric integrity after 6, 12 and 24 months of distribution revealed that the proportion of Olyset Plus with holes was 13.8% (368), 27.9% (368) and 64.6% (268); and that of Olyset Net was 26.4% (387), 39.3% (387) and 64.7% (309), respectively. Number and position of holes of different sizes on all cohort nets as well as those withdrawn for bioassays were counted and recorded to calculate the hole index. Attrition rate (100 minus survivorship) of Olyset Plus was 5.6% (358), 5.9% (338) and 8.4% (286) and that of Olyset Net was 7.0% (384), 4.2% (357), and 8.7% (309) respectively after 6, 12 and 24 months of distribution. Questionnaire-based surveys were carried every six months in randomly selected 30 households in each study arm and in households with cohort nets after 6 and 12 months of net distribution to collect information on net usage rate and its rate of washing.

1.2.2 Efficacy study on use of innovative ovitraps for control of *Aedes* breeding in west zone, New Delhi

The study on innovative ovitraps which were more effective (90.1% more effective) than conventional types ovitraps made by using cellulose comb were studied for the field efficacy in the Bagdola village, Delhi. The ovitraps were tested in the houses with the control ovitraps by placing them at different locations in houses, *viz*. bed room, stores, drawing rooms, lobbies *etc*. The results showed that 75% ovitrap positivity was found in the toilets followed by stores/staircase areas (58.8%), living rooms (24.5%), bedrooms (21.5%) and lobbies (15%). The follow up data also showed reduction in positivity with 20 HI and 36.6 OI in 1st follow-up; 23 HI and 33.6 OI in 2nd follow-up; 10 HI and 30 OI in 3rd follow-up and 13 HI & 16.7 OI in 4th follow-up. The control conventional ovitraps did not show any positivity. The preliminary results of the study showed that these innovative ovitraps are effective (Fig. 11) and acceptable to community. These also create awareness as well as work as indicators for the inhabitants for presence of *Aedes* mosquitoes in their houses. In addition to this, these ovitraps are safe option in cities like Delhi where household insurgencies are very common.

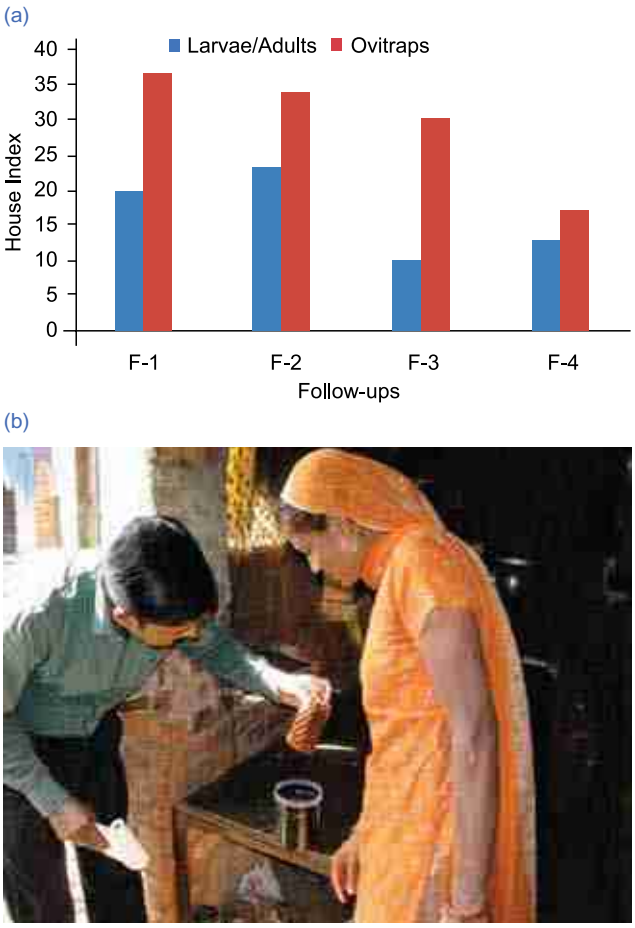


Fig. 11: (a) Graph shows comparative efficacy in positivity of houses and reduction in vector density in follow-ups; and (b) Checking of ovitrap for egg positivity.

1.2.3 Reduction of dengue transmission in Najafgarh zone of Delhi: An integrated vector management approach

Reduction in dengue transmission was attempted in 24 lanes of Raj Nagar Part II, Najafgarh zone. Two rounds of entomological surveillance were conducted. The study identified five ecotypes which were geo-referenced using GPS: (1) Households with tanker water supply having multiple storage containers; (2) Construction sites storing water in tanks; (3) Vacant plots storing solid waste; (4) Kabadi (junk) shops with junk items stored outside and (5) Households with front and side lane coolers. Nearly 22,680 breeding containers in 3200 households were checked and controlled. It was observed that around 15% of the same households were positive during both the surveillance rounds. A GIS-based risk map was generated based on ecotypes. Dengue cases recorded in NIMR Clinic were geo-referenced

using GPS and a dengue case map was generated. Validation of GIS risk map was done with respect to dengue case map, which indicated that cases clustered in and around ecotypes. Houses with tanker water and those within 20 m radius of it were found contributing around 60% of the dengue cases. It has been suggested to MCD to target households with multiple water storage containers in order to control cases in the area.

1.2.4 Vector surveillance of Zika/JE in selected high risk areas of India

Vector surveillance for Zika/JE virus was initiated in July as a comprehensive project in different sentinel parts of India. In Delhi, NIMR was identified as nodal institute for screening of Zika virus. The project was focused on screening of adult *Ae. aegypti* mosquitoes collected from various localities of Delhi as well as the mosquitoes coming from other zika suspected areas suspected through Government agencies. About 3104 *Ae. aegypti* individual mosquitoes were screened for detection of Zika virus in about 411 pools coming from 157 localities of Delhi and other cities, none of the pools was found positive for Zika till date. In addition to these, mosquitoes were also collected from Zika reported areas of Ahmedabad (369 mosquitoes in 50 pools), and none of the pool was found positive for Zika.

1.3 Insecticide Resistance

1.3.1 Impact of insecticide resistance in malaria vectors on the effectiveness of combination of indoor residual spraying (IRS) and long-lasting insecticidal nets (LLINs) in India: A multidisciplinary approach

As per the study design, universal distribution of long-lasting insecticidal nets (LLINs) was accomplished in 80 clusters (population 75,000) selected in Keshkal block of Kondagaon district during November–December 2014. An informed written consent of each household was obtained to participate in the trial. A total of 30,468 PermaNet 2.0 were supplied by the State Health Department and were distributed in study clusters. Average LLIN distribution/household was 1.99 (95% CI; 1.67–2.31) and per capita distribution as per old norms was 2.42 (National average: 2.2).

A cross-sectional survey in three selected clusters (villages) in Keshkal block of Kondagaon district to assess additional burden of sub-microscopic malaria in southern Chhattisgarh, was accomplished after obtaining informed written consent from every household participating in the study. This observational study was conducted in March–June 2016 during the low transmission season to measure and compare prevalence of malaria infection using three diagnostics: Rapid diagnostic test (RDT), microscopy and nested-PCR. Out of 437 individuals enrolled in the study, 103 (23.6%) were malaria positive by PCR and/or microscopy. Out of these 89.3% were *P. falciparum* cases, 77.7% were afebrile and 35.9% had sub-patent infections.

In the periodic blood survey of 6582 cohort of children of <12 yr of age enrolled in the study in 80 villages. In the baseline survey (November 2014), 490 children were having malaria infection (SPR 7.4%). Parasite rate (PR) was highest in villages of Dhanora PHC (16.4%) followed by Keshkal PHC (7.4%). PR among cohorts in rest of the two PHCs, Bahigaon and Singanpur was 1.95 and 0.5%, respectively. In a follow-up survey carried during June and November 2016; out of 6109 and 6155 cohort children screened for malaria infections, 39 (PR = 0.67%) and 41 (PR = 0.67%) were found positive for malaria parasites respectively showing a reduction of 91%, as a result of LLIN intervention, and high compliance rate.

Fortnight fever surveillance of cohort children by Mitanins (124) and non-cohort population by the Malaria Surveillance Workers (30) was completed on November 2016. In 9237 follow-ups, 263 malaria cases were recorded. Overall incidence was 28.4 (malaria cases per 1000 person per year). In 36 months of follow-up 0.22 million data were collected and uploaded to an online data management programme developed by the National Informatics Centre, Raipur.

Another study was carried out to evaluate the feasibility of involving *Mitanin* in active malaria surveillance work in 80 tribal villages of Chhattisgarh and to explore the challenges and determinants to perform malaria surveillance activities by the *Mitanins*. A total of 162 *Mitanins* were selected and divided into two age and village matched groups. The first group of *Mitanins* (training plus) was given additional training in malaria surveillance activities whilst the second group (standard) received routine training. Performance of *Mitanins* was evaluated using pre-defined grading scores (A—E) which included various factors such as educational qualifications and knowledge about malaria, its

signs and symptoms and knowledge, attitude and treatment practices. *Mitanins* in training plus group showed better performance (≥ B) than those in the standard group (80% *vs* 43.5%, $p = 0.001$) after adjusting for socio-demographic factors. In-depth interviews, revealed that lack of adequate support from supervisors, delayed payment of incentives and lack of appreciation were the major challenges faced by the *Mitanins*.

Susceptibility tests carried out in 2016–17, by exposing wild-caught *An. culicifacies* females collected from all clusters, to deltamethrin 0.05% indicated that the vector was resistant in 12 clusters. It exhibited possible resistance in 43 clusters and was found susceptible in 25 clusters with average mortality of 94.3% (range 77.5–100%). This indicated no consistent correlation in phenotypic resistance of *An. culicifacies* in cluster-specific mortality between the years.

Synergistic bioassays were carried out using PBO and TPP on wild-caught *An. culicifacies* to identify the biochemical mechanism of resistance in the vector. Mosquito collections were made in sentinel villages to monitor the vector density, *An. culicifacies* females were dissected to determine parous rate. Blood meal and sporozoite ELISA were carried out to determine the blood feeding preference (HBI = 0.031) and sporozoite rate (SR = 0, n = 822). Cytotaxonomic identification of sibling species complex of *An. culicifacies* revealed that species B was dominant and accounted for 90% while species C accounted for 10%. A minor increase of ~7% in gravid mosquitoes in outdoor mosquito's prevalence in IR villages and a decrease of ~4% of fed mosquitoes compared to non-IR villages were observed.

1.3.2 Monitoring of insecticide resistance in malaria vector *An. culicifacies* at different districts of Chhattisgarh

Indoor residual spraying of insecticide-based intervention for malaria control is still an important component of the VBD management in India. The major impediment for effective vector control is development of resistance to insecticides in malaria vectors. The present study was aimed to generate data on the insecticide resistance in malaria vectors in different districts of Chhattisgarh state.

Susceptibility tests were carried out in all 27 districts of the state. It was not felt necessary to undertake tests against all the insecticides in all the districts. Hence, tests against commonly used insecticide, *viz*. DDT and alpha-cypermethrin were carried out in few districts only. However, care was taken to select districts in which these insecticides are being routinely used for indoor residual spraying and also in few districts in which they are not being used. In Chhattisgarh, DDT 50% WP is being sprayed in 21 districts not considered malaria endemic in north and central parts of the state while seven districts in the south (erstwhile Bastar district) are being surveyed with alpha-cypermethrin 5% WP, preferably two rounds depending upon the availability of required quantity of insecticide. Tests were carried out from November 2014 to August 2016. Tests were carried out against the insecticide treated papers of DDT 4% and alpha-cypermethrin 0.05%. These insecticides have routinely used in malaria control programme in the state. Besides these, the tests were also carried out against malathion 5% (an organophosphate insecticide), two more dosages of alpha-cypermethrin 0.01 and 0.1%, deltamethrin 0.05%, permethrin 0.75% and bendiocarb 0.1% (a carbamate insecticide). *Anopheles culicifacies* was tested against, DDT 4% in 15 districts, malathion 5% in 18 districts, alpha-cypermethrin 0.05% in 11 districts, deltamethrin 0.05% in 26 districts and bendiocarb 0.1% in 21 districts. It was also tested against alpha-cypermethrin 0.01 and 0.1% and permethrin 0.75% in 16 and 5 districts, respectively. Mean mortality against DDT was recorded as 5.5% (95% confidence interval: 3.2–7.8); malathion 64.1% (95% CI: 59.3–68.9), alpha-cypermethrin 42.0% (95% CI: 31.4–52.6); deltamethrin 68.5% (95% CI: 62.3–74.7); bendiocarb 93.1% (95% CI: 89.8–96.6); alpha-cypermethrin 0.01 and 0.1% test papers was recorded as 5.8 (range 0–24%) and 62.1% (34.3–96.3), respectively while against permethrin 0.75% it was 80.9% (range 65.3 – 91.6). It may be pointed out here that malathion has not been used in the malaria control programme in Chhattisgarh state, while permethrin and bendiocarb are not recommended for use by the NVBDCP. Resistance against malathion and, permethrin and bendiocarb may be due to their use in agriculture causing exposure of *An. culicifacies* adults or its aquatic stages, thereby conferring resistance against them.

1.3.3 Impact of thermal conditions on the survival and susceptibility of mosquito vectors to temephos

The objective of the project was to study the effect of temperature on survival/development

of mosquito larvae. The temperature of water in different containers differed significantly with environmental temperature under laboratory as well as field conditions resulting in significant variations in the developmental period of larvae.

A field survey was continued to search breeding of *Aedes* in three municipal zones of Delhi, South, Najafgarh and Shahdara North zones. Larval indices were highest in South zone followed by Shahdara North and Najafgarh zone where House index was 17.1, 5.0 and 4.7; Container index was 7.0, 1.9 and 1.7; and Breteau index was 25.6, 5.6 and 5.3 in South, Shahdara North and Najafgarh zones, respectively. Among all the positive containers, highest positivity of *Ae. aegypti* larvae was recorded in plastic containers in South zone (86.90%), Najafgarh zone (70.58%) and Shahdara North zone (63.15%). Earthen pots were the second most positive containers in Shahdara North zone (21.05%) and 11.76% in Najafgarh zone. The role of desert coolers in breeding of *Aedes* mosquito was found negligible. The study showed that plastic containers and earthen pots were the most productive containers for *Aedes* breeding. In order to know the effect of temperature on insecticide sensitivity of mosquito larvae, *Aedes* larvae reared at 22, 26, 28, 30, 34 and 38°C temperatures were exposed to different doses of temephos insecticide. Assay of α- and β-esterase, acetyl cholinesterase, and *p*-nitro phenyl acetate (PNPA) esterase enzymes in the larvae is being done. ❑

Parasite Biology 2

2.1 Mapping of Kelch 13 molecular marker in *Plasmodium falciparum* malaria patients across International Border states in Northeastern region of India

To map the extent of *Kelch13* gene mutations in the Northeastern region of India, DNA extracted from malaria patient samples were sequenced and analyzed for polymorphism associated with artemisinin resistance.

A total of 415 *P. falciparum* patients consented for participating in this study. The *Pfk13* gene was successfully sequenced in 388 *P. falciparum* samples collected from four study sites namely—Tripura (n = 127), Mizoram (n = 154), Meghalaya (n = 84) and Arunachal Pradesh (n = 23) (Fig. 1). All the eligible patients were between the age group of 1 to 62 yr. The parasitaemia ranged between 221 and 93622/µl of blood and 88.9% patients were febrile at the time of enrolment.

A total of 12 mutations (eight non-synonymous and four synonymous) were observed in samples collected from five states in Northeastern region of the country. However, no key mutations (C580Y, R539T, I543T and Y493H) were detected, that have been associated with artemisinin resistance *in vitro* in recent studies. In the present study, no clinical or phenotypic correction was observed for the one NS mutation associated with day three positivity observed in Mizoram site bordering Bangladesh.

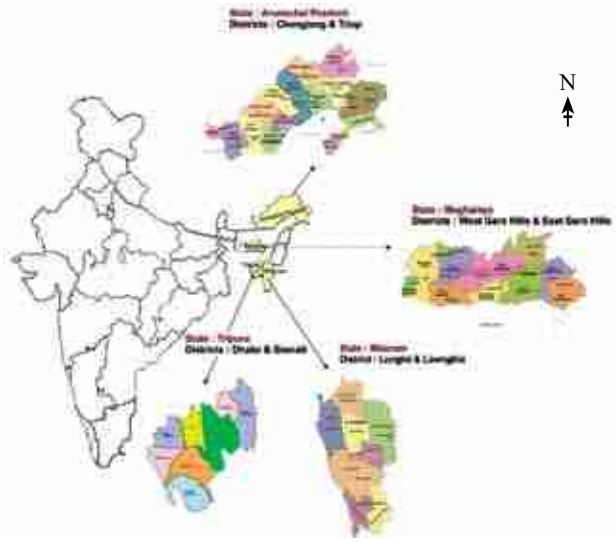


Fig. 1: The location details of study sites for Kelch mapping in NE region, India.

2.2 Molecular characterization of 4-diphosphocytidyl-2C-methyl-D-erythritol (IspE) kinase gene from *P. vivax*—ligand recognition in a template for antimalarial drug discovery

In the pursuit of development of novel drugs to tackle resistance in malaria species, a search for new antimalarial compounds has been intensified. Methylerythritol phosphate (MEP) pathway for synthesis of isoprenoid precursors has emerged as an essential metabolic pathway and its enzymes as prominent target candidates for drug intervention studies in bacteria and parasites. The fourth enzyme, 4-diphosphocytidyl-2C-methyl-D-erythritol kinase (IspE, EC 2.7.1.148) which belongs to GHMP kinase family, is the only kinase enzyme in MEP pathway. It catalyzes the ATP-dependent phosphorylation of 2 position hydroxyl group of CDP-ME (4-diphosphocytidyl-2C-methyl-D-erythritol), yielding CDP-MEP (4-diphosphocytidyl-2C-methyl-D-erythritol 2-phosphate) in the presence of Mg^{++}. The absence of IspE orthologue in the human host and its vital role during intraerythrocytic stages of *P. falciparum* renders this enzyme as unique and excellent novel antimalarial drug target. Thus to explore the feasibility of plasmodium IspE as a drug target, a molecular and *in silico* approach was employed to investigate the IspE gene from *P. vivax* (*Pv*IspE). We screened a knowledge-based curated

library of known IspE inbihitor against *Pv*IspE protein model using patchdock and firedock docking modules. On the basis of docking parameters such as 'global free energy', 'attractive & repulsive Van der wall forces' and 'area of interaction' along with visual inspection, three compounds for biochemical screening were shortlisted against purifuied *Pv*IspE enzyme (Fig. 2).

For the biochemical screening, *Pv*IspE protein were cloned in pET24a cloning vector. Positive clones were expressed in *E.coli* BL21 (DE3) expression host and recombinant *Pv*IspE protein was purified using affinity chromatography. The expression of recombinant protein was confirmed by loading, before induction, 4 hr after induction and 16 hr after induction samples on 12% SDS-PAGE (Fig. 3).

Kinetic parameters of *Pv*IspE recombinant protein were determined using luminescence-based enzymatic assay. Km value for the substrate CDP-ME was 277 µM and Vmax 7.58 µM/min/mg (Fig. 4).

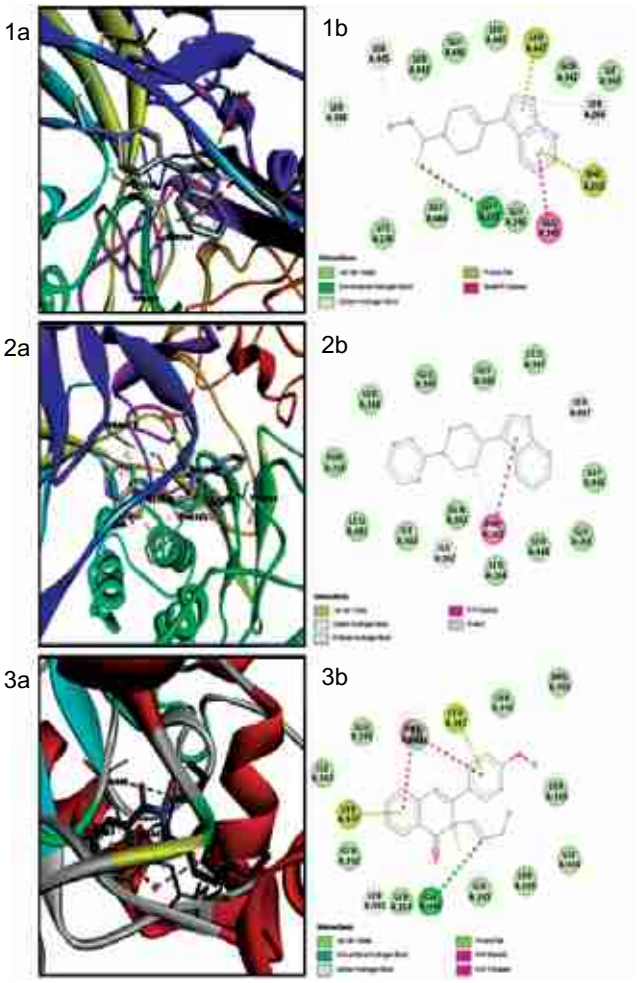


Fig. 2: Docking pose of selected inhibitors with *Pv*IspE and predicted interacting amino acid residues along with type of interactions of selected compounds (1, 2 and 3).

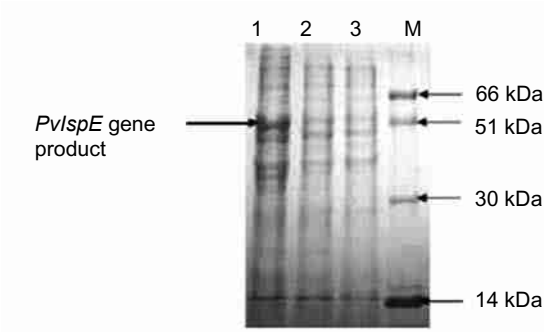


Fig. 3: SDS page analysis of purified PvIspE protein. Lane 1: 16 hours after induction sample (whole cell extract); Lane 2: 4 hours after induction sample (whole cell extract); Lane 3: Before induction sample (whole cell extract); and M: Protein marker [Protein expression checking (PvIspE), loaded on 12% SDS-PAGE].

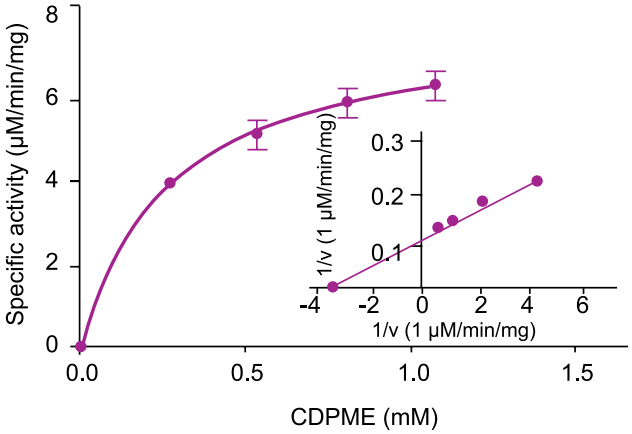


Fig. 4: Steady-state kinetic analysis of *Pv*IspE enzyme. Michaelis-Menton graph showing specific activity *vs* CDP-ME concentration.

The biochemical screening of selected inhibitors is in process. Our results strengthen the candidature of *Plasmodium* IspE as a novel drug target and set a firm base for structure-based drug designing approaches paving the way for the therapeutic exploitation of *Plasmodium* IspE inhibitors for the effective treatment of malaria.

2.3 Molecular characterization of *P. falciparum* phosphoethanolamine methyltransferse (*Pfpmt*) gene: A novel antimalarial drug target

Phosphatidylcholine (PC) synthesis is the most essential phospholipid synthesized through serine-decarboxylase-phosphoethanolamine-methyltransferase (SDPM) pathway in *P. falciparum,* at very fast rate for the rapid multiplication of the *P. falciparum* within human host. Phosphatidylcholine is the most abundant phospholipid in *Plasmodium* membranes. Parasite requires phosphatidylcholine for growth, rapid multiplication at blood stages

(rings, trophozoites, and schizonts) and for gametes development within the host. Essential enzyme *P. falciparum* phosphoethanolamine-methyltransferase (*Pf*pmt) was used as drug target for rational drug designing. Asinex compound library was virtually screened based on *in silico* interaction affinity for *Pf*pmt, ADME and toxic parameters. Top scored compounds were procured and tested in *P. falciparum* culture and IC_{50} was calculated where five compounds inhibited the 50% of parasitaemia at IC_{50} in lower micromolar concentration.

Since there was no mutation found among *Pf*pmt (Indian) isolate as compared to reference gene (*Pfpmt* 3D7), amino acids sequence of Indian isolate of Pfpmt has 100% identity with *Pf*pmt 3D7, implied that both are structurally and functionally similar. Crystal structures of *Pv*PMT and *Pk*PMT bound to the substrate SAM and phosphate demonstrates that the PMT active site is hydrophobic. The general structural folds of *Pv*PMT, *Pf*PMT and *Pk*PMT are very similar with all atom RMSD = 0.452 Å. The active site residues are well-conserved amongst enzymes from *P. falciparum, P. vivax* and *P. knowlesi*. An active site inhibitor could potentially inhibit all three (*Pf, Pv, Pk*) PMTs and such an inhibitor can be developed as a broad-spectrum antimalarial drug. Inhibition studies confirmed that drugs known to inhibit *Pf*PMT also inhibit *Pv*PMT and *Pk*PMT. Hence the crystal structure of *Pf*pmt 3D7 (PDB ID: 3UJ9) was used for virtual screening of compound library. Compound library was built from Asinex compound library.

Binding sites of pCholine or pEth and AdoMet or AdoCys are adjacent to each other and their catalytic dyad is formed between Tyr19 from pCholine or pEth and His132 AdoMet or AdoCys (Fig. 5). Important tyrosine residues for Protein activity forms interaction with co-crystallized with phosphocholine (pCholine) Crystal structure of *Pf*pmt 3D7 (PDB ID: 3UJ9) co-crystallized with pCholine was used for virtual screening of compounds using Glide module of Schrodinger *v*9.6. Grid was intensified up to 12 Å in XYZ direction so that compound can move easily within the pocket and can generate ideal conformation. The Asinex compound library was subjected for computational ADMET analysis. Only 500 compounds could pass the ADMET filter applied.

Since, solubility plays significant role from dissolution to the drug action and according to the DS 3.5, for a druggable compound solubility must be ranging from extremely low solubility (□8.0) to an optimal solubility (0). Solubility levels 3 (good solubility) and 4 (optimal solubility) signified that selected five compounds have druggable solubility as given in (Table 1).

According to the DS 3.5 the lipophilicity (ALogp98) value should range between the –2.0 and 5.0 and PSA should not be more than 140 Å for good intestinal absorption. Absorption levels 0 and 1 suggested that selected compounds have good and moderate absorption, respectively as given in (Table 1). A total of 500 compounds could pass the all the drug likeliness screening filters. Therefore, the selected top five compounds may permeate the cells and may be absorbed in the intestine. On computational toxicity analysis, selected compound inhibitors of *Pf*pmt showed no affinity for Cyp2d6 (Cytochrome enzyme) and plasma proteins. Thus, these may not be responsible for any kind of drug-

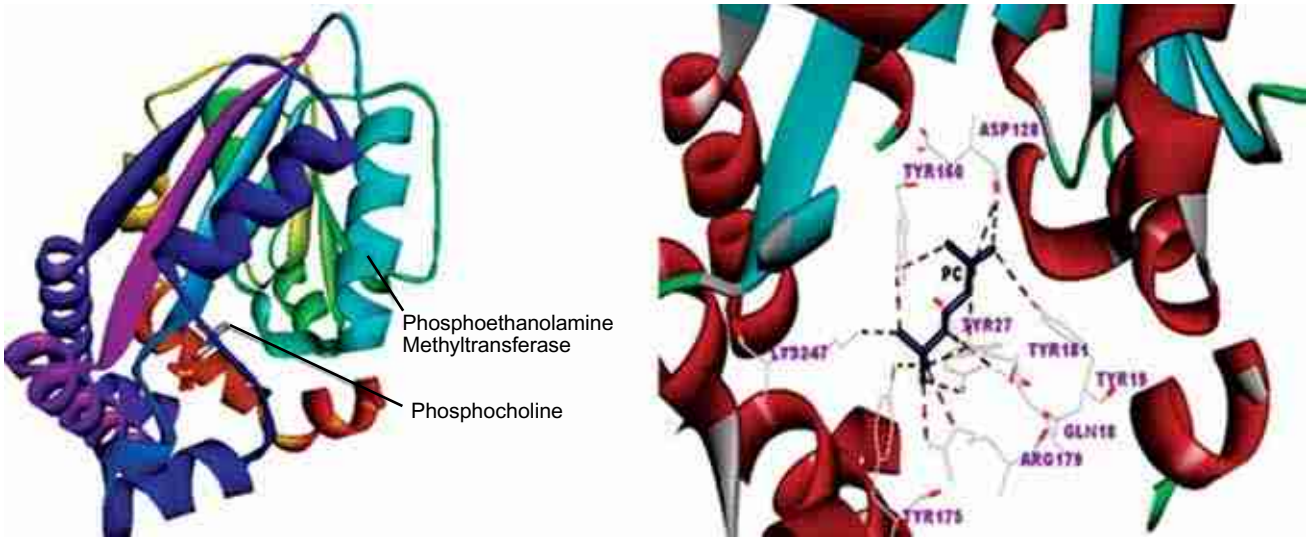


Fig. 5: Active site crucial residues of AdoMet/AdoCys and pEth/pCholine.

Table 1. Docking score and binding energy of selected compound with interacting amino acids and virtual ADME parameters as per Lipinski rule of five of selected compounds

Compound ID	Glide score	Binding energy	IC_{50} (μM) (Schizonticidal)	ROS violation	Solubility	Solubility level	AlogP98	Absorption level
ASN.25	–12.3	–110.2	0.19	0	–2.6	3	1.5	0
ASN.8	–9.81	–98.4	0.53	0	–3.2	3	2	0
ASN.3	–9.67	–102.3	1.774	0	–3.7	3	2.7	0
ASN.31	–9.67	–106.9	3.211	0	–3.6	3	2.8	0
ASN.5	–9.66	–96.8	3.933	0	–2.4	3	1.9	1

Table 2. Virtual toxic physicochemical parameters analysis of selected compounds

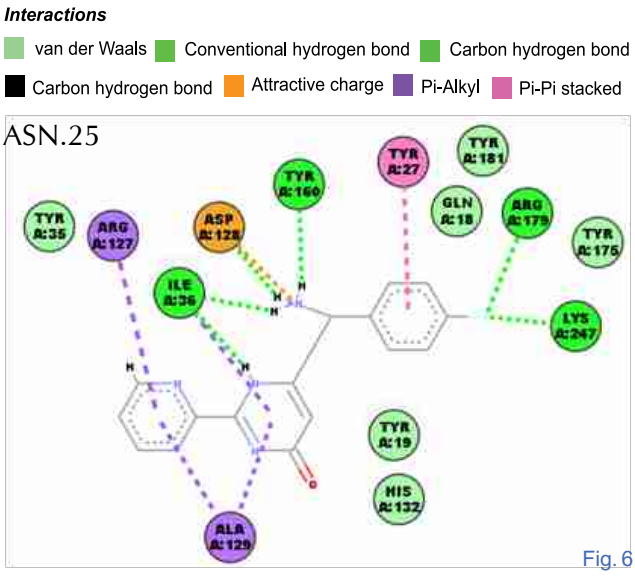
Compound ID	Cyp2d6 prediction	Ames prediction	Carcinogen prediction	Toxicity	Hepto toxicity	Plasma protein binding
ASN.25	False	Non-mutagen	Non-carcinogen	Non-toxic	False	False
ASN.8	False	Non-mutagen	Non-carcinogen	Non-toxic	False	False
ASN.3	False	Non-mutagen	Non-carcinogen	Non-toxic	False	False
ASN.31	False	Non-mutagen	Non-carcinogen	Non-toxic	False	False
ASN.5	False	Non-mutagen	Non-carcinogen	Non-toxic	False	False

drug interaction and retention of these compounds within the human body. These were also passed toxicity filter and also found non-heptotoxic and found to have non-toxic properties as given in (Table 2). Hence, selected compounds were found to have good to optimum drug likeness properties and also found non-carcinogen, non-mutagen, and non-toxic.

The pCholine and pEth were docked with both *Pf*pmt using Glide XP and kept as docking control. The XP score and binding energy of pCholine was found –1.8kcal/mol and –49.5 kcal/mol for *Pf*pmt, respectively. The XP score and binding energy of pEth was found –3.8 kcal/mol and –50.5 kcal/mol for *Pf*pmt, respectively.

The 500 Asinex compounds were subjected from Glide HTVS to Glide XP consecutively and the top 10 compound were selected and procured based on Glide XP score more than –7.0 kcal/mol and binding energy more than –92.2 kcal/mol. All procured compounds were tested on parasite culture in triplicate and only five compound showed good activity ($IC_{50} < 5$ μM) on *P. falciparum* culture. IC_{50} was calculated based on parasite inhibition at different concentrations and selected as primary hits for further analysis.

Five compounds showed good interaction with target protein and formed hydrogen bonds with crucial conserved amino acids for transmethylation as well as inhibition ($IC_{50} < 5$ μM) on *P. falciparum* culture (Fig. 6). Hence, the five hits may act as common inhibitors for both *Pfpmt, Pvpmt* and other *Plasmodium* orthologs worldwide.



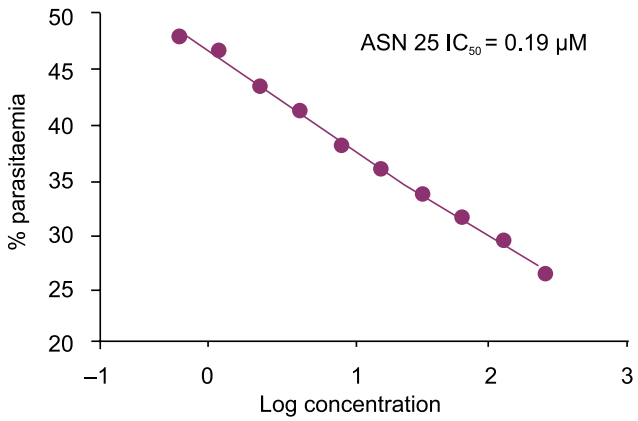


Fig. 6 *(contd...)*

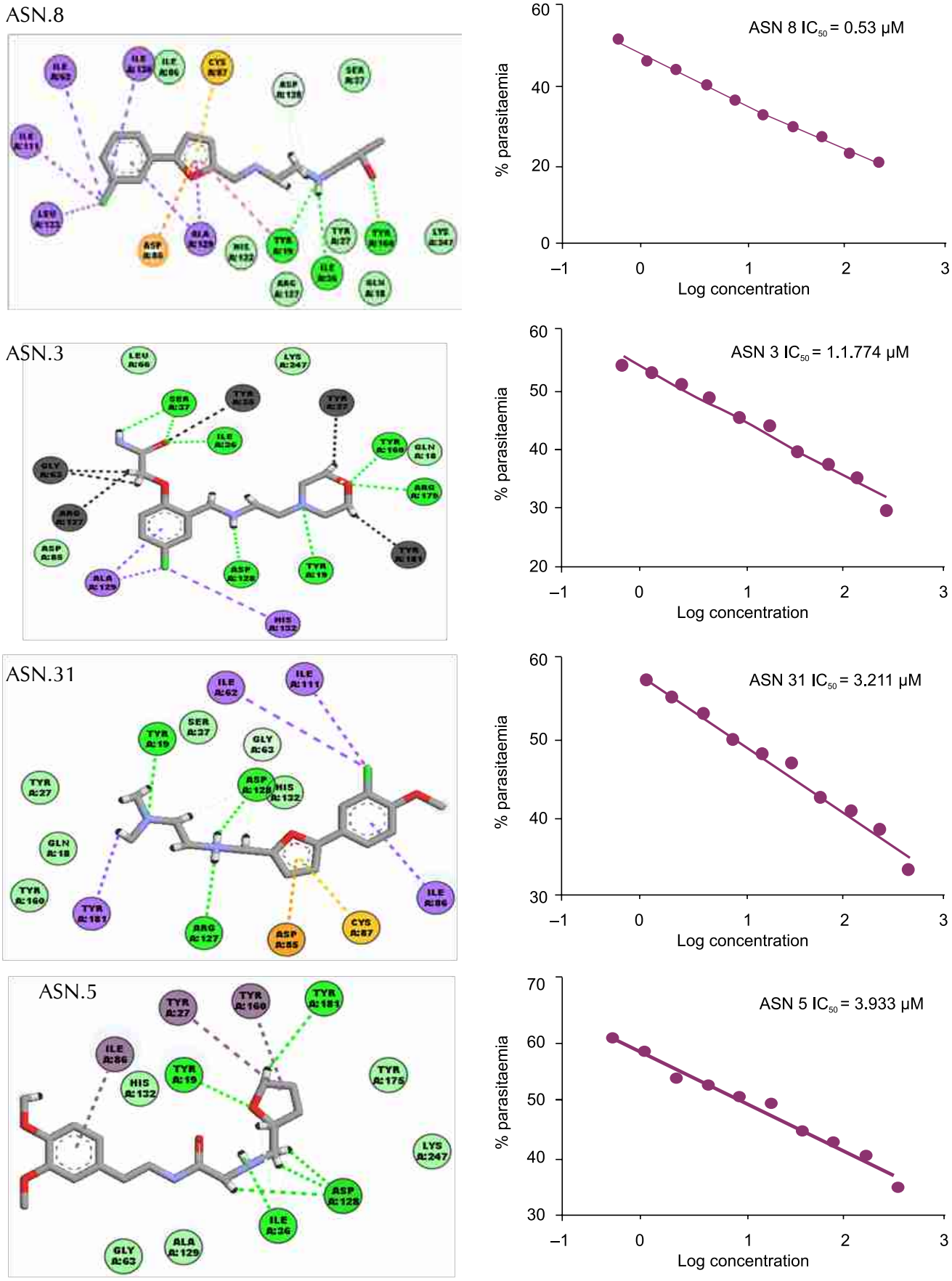


Fig. 6: Interaction of compounds (Green colour) within the active pocket and interacting amino acids and IC_{50} value of top five hits.

2.4 Identifying the molecular marker(s) for relapse malaria in the *Plasmodium vivax*

Plasmodium vivax malaria is most prevalent in India. In this study, 33 samples of *P. vivax* were collected from NIMR clinic, Delhi and 35 from sub-centre at Tain, PHC Ujina District Mewat (Haryana). The 33 samples of *P. vivax* were used for genotyping by *PvMSP3α* gene. Of the 33 samples, 30 were amplified and all the amplified samples of *PvMSP3α* gene were digested with restriction enzyme HhaI and AluI. PCR-RFLP of *PvMSP3α* gene showed highly polymorphic in nature. Polymorphic nature of *PvMSP3α* gene can be used in differentiation between relapse and re-infection of vivax malaria. The outcome will be further strengthened by genotyping of more samples.

2.5 Development of molecular tools for detection of asymptomatic malaria

Malaria is a major public health problem in India. Asymptomatic individuals of malaria maintain the parasites and contribute for continuation of malaria transmission. The diagnosis of asymptomatic malaria subject is new challenge for research and there is a need to develop sensitive diagnostic tools. In this study, a mass survey was undertaken in the villages of Marda, Potegaon (PHC Potegaon) and Birmatola, Devapur, Karvafa, Sakera (PHC Karvafa) of District Gadchiroli, Maharashtra. Blood samples were collected from 314 individuals. Of the 314 samples, one was found positive for *P. falciparum*. PCR-primers were designed for diagnosis of malaria and protocols are being standardized. ❑

Epidemiology

3

3.1 Comprehensive case management pilot programme in Odisha, India

Comprehensive Case Management Programme (CCMP) is being carried out jointly by the Government of Odisha, National Institute of Malaria Research and Medicines for Malaria Venture. It aims to assess the impact of early diagnosis and treatment, supported by a strong surveillance system, on the incidence of malaria in different transmission settings in the state of Odisha.

CCMP approach is showing expected results in low endemic block. In other blocks, there has been a significant improvement in surveillance and early diagnosis and treatment which has permitted outbreak control and preventing complications.

More than 90% of malaria patients were followed up for complete treatment. Most cases are now diagnosed and treated at the ASHA level. The time from onset of fever to treatment has decreased with the larger proportion receiving treatment within 24 hr of onset of symptoms. In all intervention areas the number of cases detected has increased except in the low endemic block Bolangir which witnessed reduction in incidence. The CCMP has programme led to a significant increase in access to diagnosis and treatment in all intervention areas. Increase in malaria cases due to improved surveillance followed by decline due to interventions has been shown in Fig. 1.

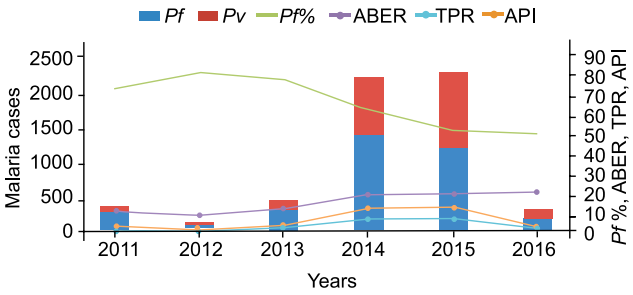


Fig. 1: Malaria in Hindol block—Initial increase followed by decline.

3.2 Efforts of malaria elimination in Punjab

With the launch of India's malaria elimination initiative, the states and UTs have a remarkable opportunity to get rid of this disease and contribute to better health and socioeconomic development especially among the country's most vulnerable populations. Punjab is one of the states which reports < 1 API in all the 22 districts for the last five years and thus qualifies for malaria elimination under Category 1. The epidemiological data of the Punjab state for the last five years are given in Table 1.

With the approval of the ICMR, a MoU was signed with the Government of Punjab and a field site unit was established by NIMR at Dhakoli CHC, Zirakpur, District Mohali (Punjab) in the month of August 2016. Preliminary information for baseline data collection from different districts of Punjab has been collected. Technical support and advisory to the state government has been envisaged under the joint collaboration so that the aim of malaria elimination in the state may be achieved within the time frame.

There is a gradual decline in malaria cases including *P. falciparum* cases over the years. These results may be further consolidated by eliminating

Table 1. Malaria situation in Punjab (2012–16)

Year	Pop.	BSC	ABER	Total +ve (*Pf*)	SPR	API	Death
2012	28589419	2911780	10.2	1689 (43)	0.06	0.059	0
2013	28645496	2971013	10.4	1761 (31)	0.06	0.061	0
2014	28778576	3092693	10.8	1036 (11)	0.03	0.036	0
2015	28984965	3000940	10.4	596 (13)	0.02	0.020	0
2016*	29081922	2900640	10	692 (7)	0.02	0.020	0

*Only 65 villages in 10 districts of the state are reporting malaria cases.

residual foci of malaria in the state. The project will help NIMR to actively participate in the malaria elimination programme of the Punjab state and to fulfil all the terms of references under MoU signed between the Government of Punjab and NIMR.

The first field survey was started in the month of August 2016 and up to March 2017. On the basis of surveillance data collected by the state government, six districts were reporting maximum number of malaria cases in the state. These districts are SAS Nagar, Patiala, Mansa, Bathinda and Ludhiana. Therefore, an action plan was prepared to first take up parasitological surveys in these six districts.

The most vulnerable villages as per available information from CHC/PHC were visited by NIMR team and carried out door-to-door surveillance to screen fever cases or patients with history of fever and the data are presented in Table 2. During surveys, none of the fever cases from Patiala, Mansa and Ludhiana was found positive for malaria probably due to low sample size. However, in Bathinda district, 24 malaria cases were detected out of 153 patients (PI 0.8%) from Goniana and Talwandi Sabo areas. In SAS Nagar (Mohali) 5 cases including one *Pf* case was detected from migrant labourers from brick kilns. In all these surveys, local staff from CHC/PHC and district headquarters were accompanied the NIMR team to provide technical and logistic support.

Malaria Clinic is operational at NIMR Dhakoli that caters to the patients reported at the CHC. The clinic services were started *w.e.f.* 21 September 2016 and up to March 2017, 1252 blood slides were examined out of which 13 were positive (*Pv*-12; *Pf*-1). The month-wise data are shown in Table 3.

A large labour force coming from malaria endemic states are working in Punjab in Agriculture, brick kilns and other small-scale industries. Therefore, malaria cases reported during NIMR surveys as well as CHC/PHC were investigated to know whether the case is indigenous or imported. Out of 33 cases investigated through questionnaire-based survey, 10 cases (30.3%) were found in migrant labourers with movement history. The district-wise data are given in Table 4.

Table 2. Results of parasitological surveys in six districts of Punjab

District	Population surveyed	BSC	*Pv*	*Pf*	Total +ve	SPR
SAS Nagar	2885	140	4	1	5	3.6
Patiala	9674	48	0	0	0	0
Mansa	17274	37	0	0	0	0
Bathinda	29290	153	24	0	24	15.7
Ludhiana	12060	81	0	0	0	0
Fatehgarh Sahib	5060	33	0	0	0	0
Total	76243	492	28	1	29	5.9

Table 3. Malaria Clinic data of CHC- Dhakoli, Zirakpur

Month/Year	BSC	Total (+)ve	*Pv*	*Pf*
Sep 2016	300	3	3	0
Oct	621	8	7	1
Nov	160	1	1	0
Dec	16	0	0	0
Jan 2017	0	0	0	0
Feb	34	1	1	0
Mar	121	0	0	0
Total	1252	13	12	1

3.3 Phase-III of health impact assessment of Narmada basin dams and resettlement & rehabilitation colonies in MP

Health impact assessment of Narmada basin dams and resettlement & rehabilitation colonies in Madhya Pradesh initially started in 2004 in 3 major dam areas in MP, was extended further for 5 years in 2010 to cover entire Narmada Basin as Phase-II. Project was further extended as Phase-III Field Units were relocated at Bhopal, Indore and Sanawad covering 20 problematic dams.

Under this entomological, parasitological and microbiological (water quality) studies were undertaken to identify problems related to vector borne diseases in the affected area of 20 dams of Narmada basin. Mitigation measures were suggested to NVDA and the State Health Department, *i.e.* de-weeding, introduction of larvivorous fishes, channelization of pools in main river and larvicidal spray to control the breeding. Health camps were organized involving Health Department in Narmada Basin area for the awareness of vector borne diseases and their possible controls.

Table 4. Proportion of migrant/imported cases in five districts of Punjab

District	No. of malaria cases investigated	No. of migrants (Imported cases)	Percentage of migrants
SAS Nagar (Mohali)	6	6	100
Patiala	5	1	20
Mansa	5	0	0
Bathinda	11	0	0
Ludhiana	6	3	50
Total	33	10	30.3

3.4 Mapping of malaria risk in the context of climate change in India

The activities of the project were continued with the objectives of generating risk maps of malaria from the view-point of malaria prevalence, climatic determinants, climatic suitability, malaria vector's distribution and ecological risk and in view of climate change in India with emphasis on creating layers for forest, NDVI, soil, slope and altitude maps, so as to generate a composite risk map of malaria. The ecological risk at village-level was also deduced in respect of Dantewada district (Chhattisgarh) and Koraput (Odisha) using 5.8 m resolution of satellite data. Field visit was undertaken in Dadar & Nagar Haveli for ground truth.

The map based on climatic parameters reveals that by the year 2030, many foci are projected to show reduction in transmission intensity of malaria against the baseline year of 2008. A few new foci are expected in Himalayan states like Uttarakhand and Himachal Pradesh. The soil drainage map and types of dwellings were found one of the critical factors for low malaria endemicity in Kerala. Tools for early warning of malaria outbreaks using case mean ratio and rainfall cut-off have been firmed up.

3.5 Validation of Roy's model ensuring anti-relapse drugs in elimination of *Plasmodium vivax*

Roy *et al* (2013) have modeled that vivax malaria can be eliminated in 5 years if treated with antirelapse drug primaquine 14 days regimen. In this study, we have selected subcentre Tain, PHC Ujina, Mewat, Haryana. Village-wise fever survey was undertaken and a total of 228 malaria patients were identified among the village population of 17,662 (Andhaka (10/846), Dhadhuka (8/998), Husainpur (3/520), Machroli (4/1553), Raipuri (120/2359), Satputiyaka (6/728), Sudaka (49/5396), Tain (7/4853), and Tarkpur (21/409). Of the 228 malaria patients, 223 were positive for *P. vivax* and 5 for *P. falciparum*. The patients were treated as per the national drug policy. Maximum number of vivax malaria patients were found in the age group of 1–10 years (40.3%) followed by 11–20 years age group (38.1%), 21–30 years age group (11.6%), 31–50 years age group (8%) and >50 years age group (1.7%). Among 223 *vivax* malaria patients,107 were male and 116 females. The API has decreased. ❑

Clinical Research 4

4.1 Monitoring the therapeutic efficacy of antimalarial medicines in Chhattisgarh

Therapeutic efficacy of ACT was monitored in Antagarh CHC, Kanker district, Chhattisgarh where it is being used as a first line of treatment for uncomplicated *P. falciparum* malaria positive cases. In the present study, 85 cases at Antagarh CHC, District Kanker fulfilling the inclusion criteria were enrolled in the study. In all, 85 patients with uncomplicated *P. falciparum* mono-infection were given ACT under medical supervision over 3 days as per the National Drug Policy. All the patients enrolled in the study, administered with drug were followed-up to 42 days from Day 0 (Day of enrolment) for parasitological and clinical evaluation. Haemoglobin was checked on Day 0 and Day 42. In all, 83 patients completed the 42 days follow-up. Two patients were lost in follow up. The 42-days cure rate with ACT (Artesunate plus sulphadoxine-pyremethamine) (AS + SP) was 100% and no clinical or parasitological failure was recorded. All the patients tolerated the drug very well and no adverse event was observed. The study indicates that response of 3-dose regimen of ACT (AS + SP) is effective in clearing the asexual parasitaemia in 100% of patients within three days. Therefore, ACT (AS + SP) should be continued as first line of treatment for uncomplicated *P. falciparum* malaria in chloroquine resistant high risk areas.

4.2 Monitoring of therapeutic efficacy of anti-malarial medicines in India

During the year 2016–17, 15 therapeutic efficacy study sites were selected in consultation with NVBDCP. Out of these, studies have been completed at three sites in NE region (Lawngtlai district, Mizoram; West Garo Hills district, Meghalaya; and Dhalai district, Tripura) for efficacy of artemether-lumefantrine (AL) in *P. falciparum*, five therapeutic efficacy studies of AS + SP in uncomplicated *P. falciparum* malaria at Betul district, Madhya Pradesh; Keonjhar district, Odisha; Kanker district, Chhattisgarh; Simdega distict, Jharkhand; Kolkata (Urban), West Bengal, and one site in Mangalore district, Karnataka. The efficacy of Chloroquine (CQ) in *P. vivax* malaria was also studied.

The studies conducted during 2016–17 have shown that the efficacy of AS + SP at five sites ranged between 95.5–100% after 28-days of follow-up and the efficacy of artemether-lumefantrine (AL) in *P. falciparum* malaria in Northeastern region ranged between 98.6–100% at three sites (Fig. 1). The efficacy of chloroquine (CQ) in *P. vivax* remains 100% at one site.

A random 20% samples were analyzed for single nucleotide polymorphisms in *dihydrofolate reductase* (*dhfr*) and *dihydropteroate synthase* (*dhps*) genes. Mutations in the *dhps* and *dhfr* genes, both coding for essential enzymes in the folate biosynthesis pathway, mediate drug resistance to SP. At AS + SP study sites, majority of the samples (70.7%) showed *dhfr* double mutation. In contrast, majority of the samples showed dhps single mutation (39%) followed by wild type, double and triple mutations. Also, the K76T mutation in chloroquine transporter gene (*Pfcrt*) was observed in majority of samples (58.5%). However, 4.9% samples could not be amplified. Also, for NE region, majority of the samples showed double mutation in *dhfr* and *dhps* genes.

To monitor the lumefantrine resistance pattern, single nucleotide polymorphisms in *P. falciparum* chloroquine resistance transporter (*Pfcrt*; K76T) and *P. falciparum* multidrug resistance 1 (*Pfmdr1*; N86Y, Y184F, D1246Y) genes were studied as molecular

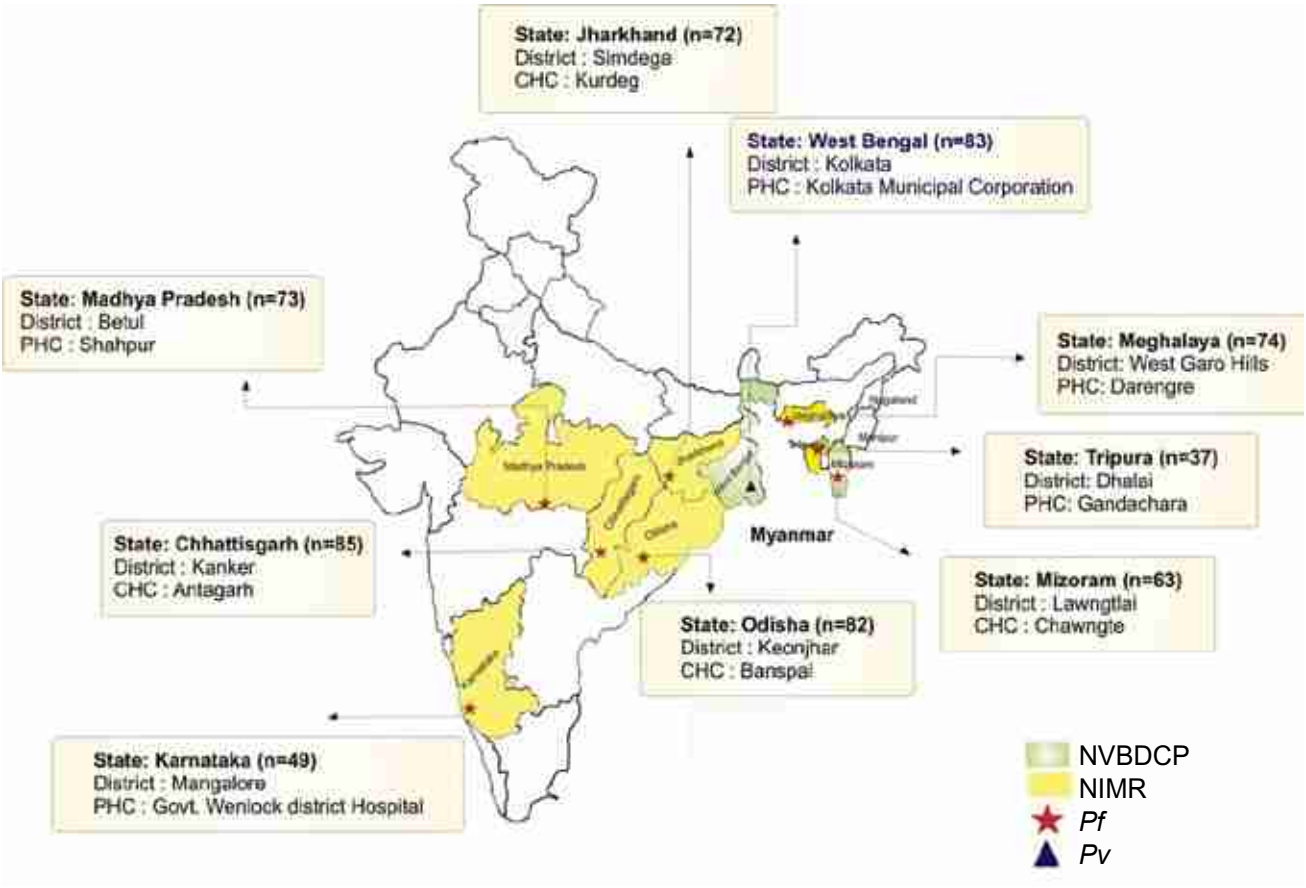


Fig. 1: Study sites for therapeutic efficacy of various ACTs in India.

markers of emerging resistance in 100% samples obtained on Day 0 from the Northeastern sites. Majority of the samples showed wild type pattern for codon 86, 184 and 1246. The K76T mutation in chloroquine transporter gene (*Pfcrt*) was observed in majority of samples (67.8%). No adverse events were observed during the study.

Till date, the data generated showed that the prescribed antimalarials, ACT (AS + SP and AL) in *P. falciparum* and chloroquine in *P. vivax* malaria patients by the national programme are effective and safe.

4.3 Clinical development of antimalarials

The NIMR is actively involved in clinical development of antimalarials, and currently two clinical trials are ongoing.

4.3.1 Phase IIIb trial to assess the safety, tolerability and efficacy of dihydroartemisinin/piperaquine (Eurartesim®) in Indian children and adolescent patients with acute uncomplicated *P. falciparum* malaria

This multicentre, phase-IIIb, single arm trial was carried out at two centres: Rajendra Institute of Medical Sciences, Ranchi and Government Wenlock Hospital, Mangalore. It aimed to assess the safety, tolerability and efficacy of Eurartesimoral film coated tablet formulation (160/20 mg or 320/40 mg PQP/DHA) in children and adolescent patients with acute uncomplicated *P. falciparum* malaria.

4.3.2 Multicentre, open-label randomized trial to assess the efficacy, safety and tolerability of triple artemisinin-based combination therapies (TACTs) compared to artemisinin-based combination therapies (ACTs) in uncomplicated falciparum malaria and to map the geographical spread of artemisinin and partner drug resistance

This is an open-label randomized trial compared standard ACT treatment with that of triple artemisinin-based combination therapies (TACTs), evaluating efficacy at sites experiencing ACT failure and safety, tolerability and artemisinin and partner drug resistance at all sites.

The trial is being carried out at three centres: Agartala Government Medical College; Ispat General Hospital, Rourkela; and Medical College, Midnapur. A total of 240 patients have been enrolled so far.

4.4 Active pharmacovigilance for primaquine radical cure for the treatment of *P. vivax*

The project, being carried out in Odisha, tries to assess the drop of haemoglobin and recovery following 14-day primaquine treatment for *P. vivax* radical cure. Patients with confirmed vivax malaria, and having haemoglobin level of more than 7 g/dl were included in the study. The study enrolled 100 patients. Maximum fall in mean Hb was observed by Day 3; while as there was recovery by Day 42 (Fig. 2). No haemolytic symptoms were observed in enrolled patients. Preliminary analysis indicates that primaquine causes haemolytic anaemia in a fraction of patients. Further investigations are needed to understand the G6PD status of the subjects

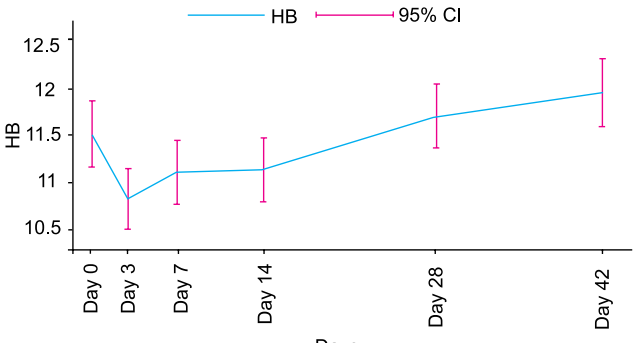


Fig. 2: Average change in haemoglobin level over time.

4.5 Evaluation of Dengue Rapid Diagnostic Test Kits

Evaluation of nine brands of rapid diagnostic combi kits for diagnosis of dengue was carried out as a part of ICMR programme, in consultation with the National Vector Borne Disease Control Programme and the Central Drugs Standard Control Organization. Apart from the National Institute of Malaria Research, National Institute of Virology, Pune also carried out the evaluation. Nine commercially available combo kits those can detect dengue NS1 antigen and IgM antibody were evaluated. Overall sensitivity of the kits was greater for detection of NS1 antigen compared to detection of IgM antibodies. Thus, these kits can be useful for diagnosis of dengue in early stage.

4.6 Fever Clinic

At fever clinic, 103 malaria cases were diagnosed, out of which 99 were *P. vivax* and 4 *P. falciparum*. Out of these 103 malaria cases, 63% were males while 37% were females. Peak of the malaria cases was seen in the month of August and September (Fig. 3). All the confirmed malaria cases were given treatment as per the national treatment guidelines.

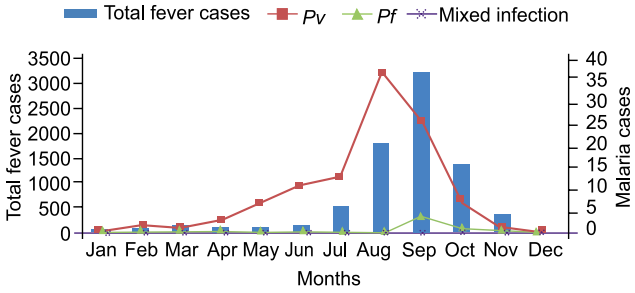


Fig. 3: Malaria cases in 2016.

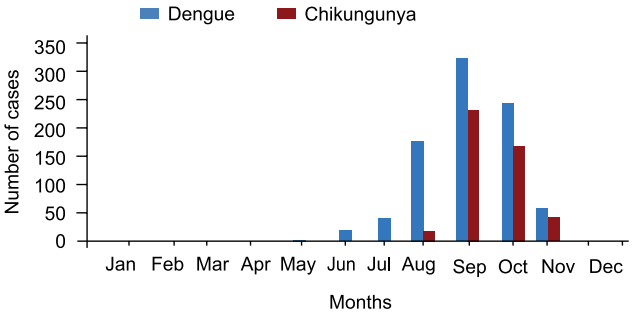


Fig. 4: Dengue and chikungunya cases in 2016.

NIMR is one of the sentinel surveillance site for diagnosis of dengue and chikungunya. A total of 770 dengue cases and 1753 chikungunya cases were diagnosed in 2016 (Fig. 4). Out of total dengue cases, 62% were males and 38% were females. Maximum number of cases reported in the month of September. All the confirmed dengue cases were advised regarding intake of plenty fluids, use of antipyretics and to avoid anti-inflammatory drugs and were referred to hospital for further investigations and management. ❑

Highlights of the Research Activities

5

5.1 Bengaluru (Karnataka)

- IRS with SumiShield (Clothianidin–A neonicotinoid insecticide) was found effective, operationally feasible and safe. It is effective up to six months.
- *Plasmodium falciparum* was found effective to artemisinin + sulfadoxine-pyrimethamine In Mangalore.
- The exo-erythrocytic form (EEF) of *P. vivax* has been successfully cultured *in vitro* in HCO4 hepatic melanoma cell line.
- The exo-erythrocytic form (EEF) of *P. vivax* has been successfully cultured *in vitro* in iPSC-derived *P. vivax*-infected patient hepatic cell line. Both the projects are aimed to test for new drugs against the EEF.
- Dihydroartemisinin/piperaquine (Euratesim) was found effective in Indian children and adolescent patients with acute uncomplicated *Plasmodium falciparum* malaria.
- MozziQuit–A mosquito catching device was evaluated in Mangalore. The device trapped equal or more mosquitoes as compared with conventional traps.
- Parasite panels were prepared for quality assurance of RDTs.
- Also assisting the state health department on different aspects of vector borne diseases in Karnataka including training and capacity building.

5.2 Chennai (Tamil Nadu)

- *In vivo* studies on the therapeutic efficacy of chloroquine to *Plasmodium vivax* malaria was undertaken in Rameswaram Island, Tamil Nadu.
- Extensive field studies on transmission of vector mosquitoes including adult (dawn and dusk) indoor resting collections from human dwellings and cattle sheds; besides, vector incrimination, host blood meal preference, susceptibility status of operational larvicide (Temephos) against immature *Anopheles stephensi*.
- Incubator studies with varied temperatures to find out duration and emergence rate of *An. stephensi* were also carried out as part of the NIH project 'Center for the Study of Complex Malaria in India (CSCMi)'.
- Assessment of malaria gametocytaemia with duration of symptoms: A potential programme monitoring tool for delay in seeking treatment was undertaken among malaria patients attending the clinic.
- A comparative study on the susceptibility of *An. stephensi* from geographically diverse ecotypes (Coimbatore and Chennai), in Tamil Nadu to *Plasmodium* species was carried out during the reporting period.
- Bottle assay method to monitor insecticide resistance in *Anopheles stephensi* and *Aedes aegypti* was undertaken.
- Monitoring of existing intervention tools/ methods in the programme for scaling-down malaria to have a strong impact with reduction of parasite incidence to an extent that would interrupt local transmission in Rameswaram Island was also initiated.
- Post flood scenario to assess the vector breeding potential in view of the unprecedented rains and subsequent flood was carried out in Chennai.
- Extensive survey was conducted in 5 districts of Kerala, namely Trivandrum, Wayanad, Ernakulam, Idukki and Pathanamthitta districts

during monsoon (June and October 2016) and later during pre-monsoon (March 2017) for the collection of *Ae. albopictus* and its subgroup species besides, *Ae. aegypti* for the ICMR funded project on 'Ecology and distribution of *Aedes albopictus* and *Ae. aegypti* with special reference to *albopictus* subgroup species of the subgenus *Stegomyia* in Kerala, India'.

- Phase-II study on the WHO funded project on 'Evaluation of SumiLarv 2MR as a mosquito larvicide for control of *Ae. aegypti* in container habitats in Chennai, India' was carried out till 36 weeks and the efficacy of the test compound was 100%.
- Further, technical support was provided to various institutes/colleges/govt. agencies and collaborative research studies were also undertaken with NIMR, Delhi and other institutes.
- Malaria clinic continued to function catering to the needs of the public by providing early diagnosis and prompt treatment.
- Out of three Ph.D. students of the field unit, one has submitted the doctoral thesis to the university during the reporting period.

5.3 Guwahati (Assam)

- A multicentre, open-label randomised trial to assess the efficacy, safety and tolerability of triple Artemisinin-based combination therapies (TRAC 2) was initiated at Mohanpur PHC in Tripura on 18 May 2016. A short-term (18–21 April 2016) training programme was organised at CHC-Mohanpur. As many as 293 fever cases were checked for malaria positivity, 20 subjects enrolled, 9 were given AL arm and 11 were given AL + AQ arm.
- The therapeutic efficacy of Artemisinin-based combination therapy of artemether + lumefantrine (AL) was evaluated in malaria endemic blocks along international borders. The study was undertaken in four different locations in Northeastern states, *viz*. PHC Silachari, Gomti district, Tripura; PHC-Chawngte in Mizoram; PHC-Darengre, East Garo Hills of Meghalaya and PHC-Miao, Changlang district of Arunachal Pradesh during June–October 2016 in collaboration with respective state Health authorities.
- Fever survey was carried out in different villages of East Garo Hills (Meghalaya) and Udalguri (Assam) during August–October 2016 to screen the uncomplicated *P. falciparum* malaria patients to enroll them for investigation. Further, infectious reservoir of malaria and prevalent parasite species, mass blood survey was also carried out in the study districts (One high API and one low API PHC) to have representative data of target population.
- Quality Assurance of Malaria Rapid Diagnostic kit were done in PHC's subcenters and villages of District Dhemaji (38 Samples) and Lakhimpur (38 Samples) during February 2016. It showed satisfactory results except that one RDT gave invalid result.
- The Field Unit provided technical support to control mosquito vector in Northeastern states. Total 54,000 *Gambusia* fishes have been supplied to Assam, Arunachal Pradesh and various military establishments in Guwahati City.
- The staff of Field Unit was also involved in different activities to coordinate training programme, member of interview board for selection of TRAC-II Project staff.
- Organized meeting in Guwahati for initiation of project "A survey to assess the infectious reservoir" (ICMR Project) in June 2016.

5.4 Haridwar (Uttarakhand)

- Situation analysis and identification of risk factors of dengue in District Haridwar: During the months of June to October 2016, a total of 696 houses were surveyed, out of which 328 houses were found positive for *Aedes* breeding. House Index (HI), Container Index (CI), Breteau Index (BI) and Pupal Index (PI) were 47.1, 51, 105.3 and 26.2, respectively. Major breeding sites in BHEL Township and Haridwar city were coolers and containers, accounting to more than 35% of the total breeding sites. Four species, *i.e. Ae. aegypti, Ae. albopictus, Ae. vittatus,* and *Ae. thomsoni* were identified and their percent compositions were 22.7, 63.2, 13.3 and 0.8, respectively. More than 70% *Ae. aegypti* were recorded in Haridwar city, whereas in BHEL Township its prevalence was only 1.8%. *Ae. aegypti* was found 100% susceptible to 4% malathion and 0.05% deltamethrin and

resistance to 4% DDT as only 7.5% population was found susceptible. It was observed that out of 1385 suspected cases, 430 cases were ELISA positive. Haridwar City recorded 231 confirmed cases and one death, contributing 53.7% of the total dengue cases of the district.

- Stratification of malaria in District Haridwar: A demonstration of elimination in one subcentre: During the months of April 2016 to March 2017, a total of 266 blood slides were collected in Chandrapuri subcentre out of which 38 cases were found positive for *P. vivax* and 1 for *P. falciparum,* SPR being 14.7, while 311 blood slides were collected from Shivgarh, out of which 3 slides were found positive for *P. vivax*, SPR being 1.0. In Chandrapuri API decreased from 13.4 in 2015 to 6.4 in 2016, while in Shivgarh API reduced from 1.27 to 0.23 during the same period. Thus more than 50% reduction of malaria was observed in Chandrapuri while 80% reduction was observed in Shivgarh. Man hour density of *An. culicifacies* was high in the villages of Chandrapuri sub-centre as compared to Shivgarh subcentre. High incidence of malaria in Chandrapuri subcentre has been attributed to the fact that the area is flood-prone with regular water logging and perennial breeding sites.
- Stratification of malaria in District Saharanpur with reference to socioeconomic and climatic factors associated with high malaria incidence: For stratification of malaria cases of District Saharanpur, PHC-wise epidemiological data of District Saharanpur has been collected. Gangoh CHC showed highest API (1.78) followed by Nakur (1.08) and Sarsaw (1.04). A total of 540 malaria cases were recorded, out of which 491 cases were *P. vivax* and 49 cases were *P. falciparum*. Prevalence of *P. vivax* was observed throughout the year with maximum number of cases occurring during the month of September. Prevalence of *P. falciparum* was observed during the months of August to October. A total of 520 malaria cases were recorded, out of which 518 cases were *P. vivax* and 2 cases were *P. falciparum*.
- Industrial malaria control: NIMR Field Unit is working on industrial malaria control from 1986 and successfully controlled malaria in BHEL, Haridwar. From April 2016 to March 2017, a total of 2164 blood slides were collected, of which 45 slides were found positive for *P. vivax*. SPR was 2.08. During the months of August–September average man hour density (MHD) of *An. culicifacies* was 25.0. Insecticide susceptibility test of *An. culicifacies* showed that it was 8.3% susceptible to DDT, 88.9% susceptible to malathion, and 100% susceptible deltamethrin, cyfluthrin and lambdacyhalothrin.

5.5 Jabalpur (Madhya Pradesh)

- After two years of use of bednets by the community, 98% nets passed the cone bioassay test as per WHOPES criterion. Loss of insecticide was between 51 and 76% after so many washes of nets. From the distributed nets 80% were available in the community and out of these 98% were in use. Only 40% nets were detected with holes of which 1.5 to 2% nets having 0.5 to 10 cm size holes. Maximum number of holes was found in lower side of nets.
- In high malaria transmission areas SPR was from 14–29% between 4 and 14 yr age group of children. However, among adults the prevalence was between 5 and 6%. In low transmission area no afebrile case found positive for malaria. Vector density was high in high transmission area throughout the year.
- Besides NVBDCP supply of RDTs when ASHAs were provided with RDTs of other companies, 55% ASHAs had difficulties in performing the test properly.
- Due to non-availability of instructions for use in the national language inside the test kits ASHAs were not able to perform rapid tests properly.
- In therapeutic efficacy trial of ACT (AS + SP) at Betul site, 76 cases were enrolled having mono *P. falciparum,* of which 7 were excluded during the 42 days of follow-up. However, only 1 patient showed late parasitological failure on Day 21 of follow-up.
- During the intradomestic breeding surveys for *Aedes* species in rural and semiurban areas, it was found that in rural area 100% Aedines were *Ae. albopictus* and *Ae. vittatus*. However, in semiurban areas 62% were *Ae. aegypti*. Cement tanks were the major breeding places (63 to 73%) in both the areas.

5.6 Nadiad (Gujarat)

- Health Impact Assessment study was initially carried out in Kheda, Surendranagar, Patan and Morbi districts in Phase-II command area of Sardar Sarovar project. It was further extended to Rapar taluka of Kutch district. Three villages from command area (Khandek, Shangadh and Thanpar) and one village (Fulparvandh) from non-command area were selected as sentinel villages. Quarterly monitoring of entomological activities, namely mosquito collection, peri-domestic and intradomestic larval surveys, host preference and survivorship of malaria vectors. Beside this, one mass blood survey was also carried out in sentinel villages for detecting malaria parasite load in the population.
- The main objectives of large-scale (Phase-III) was evaluation of efficacy, fabric integrity and community acceptability of PermaNet 3.0 long-lasting insecticidal nets compared with PermaNet 2.0 in India, besides also to determine and compare the insecticidal activity and fabric integrity of PermaNet 3.0 LNs with PermaNet 2.0 over three years of use by households under field conditions and to assess washing mode and washing habits of LNs by the householders, and to assess the community acceptability of LNs over three years under field conditions. Cohort nets survey were carried out after 24 months use of nets by householders. The activities conducted under this study were bioassay and chemical assay, as well as fabric integrity (Cohort nets).
- A research study on Fludora-Fusion 562.5 WP-SB (clothianidin 50% + deltamethrin 6.25%) for indoor residual spraying for malaria vector control in Gujarat state, India was carried out with the objectives of evaluating the efficacy and impact on vector behaviour of indoor residual spraying of Fludora-Fusion 562.5 WP-SB formulation applied at the dose of 225 mg AI /m^2 against insecticide resistant population of *An. culicifacies* in comparison with clothianidin 70 WG applied 200 mg AI/m^2, deltamethrin 250 WG applied at 25 mg/m^2, and bendiocarb 80 WP applied at 400 mg AI/m^2 , and to determine the persistence of residual action of Fludora-Fusion 562.5 WP-SB in comparison with clothianidin alone, deltamethrin and bendiocarb. To record the perception of householders and spray-men on the operational feasibility, ease of application and adverse effect of Fludora-Fusion WP-SB surveys were carried out.
- Under the project, transmission dynamics and control of malaria in tribal area of Gujarat, India, entomological parameters such as adult mosquito density, larval density, parity, human blood index and human landing collections were monitored on bi-monthly basis. Supervision of IRS activities was also done in the study area. Technical support on IRS was given to spray team at village-level and district-level authorities during spraying of insecticide. At present alpha-cypermethrin is being used for indoor residual spraying. Under epidemiological parameters, supervision of surveillance mechanism, laboratory services and mass blood surveys were also conducted.
- The project on Center for the Study of Complex malaria in India (CSCMi) is going on with an aim to understand the complexity of malaria, including changing patterns of epidemiology. Subsequently new study was started in November 2016—The epidemiology of severe malaria in Gujarat, India. The primary objective of this project in India is making progress with reducing malarious state. This is an observational cohort study, whereby patient with severe malaria were enrolled and followed until the end of hospitalization. The investigation did not involve medical treatment; only prospectively documentation of signs and symptoms, treatment and outcome of severe malaria patients admitted at Civil Hospital, Ahmedabad was recorded.

5.7 Panaji (Goa)

- A national multi-districts study entitled 'Estimation of malaria burden in India', was conducted in Kolhapur and Dakshin Kannada districts under NIMR FU Goa. Other sample districts in the country were Jaipur, Jhabua, Koraput and Chatra where similar exercise was undertaken by NIMR scientists in collaboration with NIMS and NVBDCP, Delhi. The project activity included manpower recruitment and training, active surveillance, malaria incidence reporting from private, corporate, municipal and Govt. sectors covering all stakeholders and health providers. Verbal autopsy of all death

cases was performed in a population of 2 lakh per district in death arm. The final report of the project has been prepared and discussed.

- Proteomic analysis of urine of malaria patients using high resolution mass spectrometry was performed for identification of candidate biomarkers for *P. falciparum* and *P. vivax* infections. A total of 106 peptides were identified, of which 9 peptides were found to be conserved between both *P. vivax* and *P. falciparum,* whereas 97 peptides were found to be unique to *P. vivax*.
- A study on kinetics of *P. vivax* development was conducted in the wild Goa strain of *An. stephensi*. The presence of *P. vivax* sporozoites in salivary glands was examined at different time points post-infection with patient's blood. A weak but significant correlation was found between gametocytaemia/parasitaemia and oocyst load. There was no correlation between gametocytaemia/parasitaemia and oocyst infection rates, and between gametocyte sex ratio and oocyst load. A strong positive correlation was, however, observed between oocyst midgut levels and sporozoite infection rates, and between oocyst and salivary gland sporozoite loads.
- Characterization of salivary gland proteome of dengue/DHF, chikungunya and yellow fever vector *Ae. aegypti* L was done. A large number 2265 and 1198 proteins were identified and catalogued from midgut and salivary gland, respectively. Of these, 337 and 1445 were unique to salivary glands and midgut, respectively. The functional analysis of these proteins was carried out.
- A study on the role of gut microbiota in modulation of longevity, fecundity and fitness of major malaria vector *An. stephensi* was initiated and many candidates were identified and their pure cultures were obtained. Their biochemical and molecular identification was done. Clean lines of *An. stephensi* treated with tetracycline were established for further targeted studies.
- A study conducted for isolation, characterization and efficacy of naturally occurring mosquito pathogenic bacilli from harsh environmental conditions resulted in isolation of promising mosquito pathogenic agents that were biochemically characterized and their 16S rRNA profile was done for identification at species level. They were grown on various media and for varying spans of time for harnessing maximum sporulation which was found to be at 96 hrs of growth/sporulation phase on NYSM medium. Further crude metabolite toxins were also tested against four vector species.

5.8 Ranchi (Jharkhand)

- Anopheline fauna survey was undertaken at Noamundi area West Singhbhum district. Five malaria vectors were collected during the survey. Three primary malaria vectors (*An. culicifacies, An. fluviatilis* and *An. minimus)* and two secondary malaria vectors, *i.e An. annularis* and *An. varuna* were collected. *Anopheles minimus* was found to be in low density in 12 villages of Noamundi area. High density (10–15 MHD) of *An. minimus* was recorded from Purtydigya. The resting of *An. minimus* was observed in the indoors of human dwellings. The resting of *An. minimus* was detected in the human dwellings under the sleeping beds, *machaan* inside the house, under the tables and the walls of the unsprayed houses. Mosquito blood meal analysis revealed high anthropophilic index. About 54% were positive for human blood index.
- Susceptibility test of *An. minimus* using DDT (4%), malathion (5%) and deltamethrin (0.05%) was carried out in Noamundi area. *Anopheles minimus* showed 96% mortality to DDT (4%) and 100% mortality to malathion (5%) and deltamethrin (0.05%). Six *An. minimus* were sequenced. Sequencing of 28rDNA confirmed that specimen identified morphologically as *An. minimus s.l.* were actually *An. minimus sensu stricto*.
- *Plasmodium falciparum* infections recorded through fortnightly surveillance. Malaria transmission was perennial and *P. falciparum* malaria was reported throughout the year . There were 99 cases of clinical malaria from April 2015 to April 2016 and all the cases confirmed by microscopy were attributed to *P. falciparum* (94 cases) and *P. vivax* (5 cases). The monthly incidences of *P. falciparum* and *P. vivax* were also recorded. *Plasmodium falciparum* malaria

incidence was generally higher after the end of the monsoon season and lower in the hot dry summer months. The mean density of *P. falciparum* parasitaemia was calculated for the 0–5, 6–10, 11–15, and >15 yr age groups. It increased to a peak level of 23,601 parasites/µl in the 6–10 years age group and gradually declined in the adult population to a level of 7066 parasites/µl. A similar pattern was observed in the incidence rate of febrile *P. falciparum* malaria.

- Average annual vector density determination in the study area established *An. fluviatilis* as the most prevalent vector constituting 49% of all the vector species. *Anopheles annularis* and *An. culicifacies* constituted 34 and 17%, respectively. The cumulative annual average of all the vectors captured in the study area during fortnightly surveys was 21 and 79% for vectors resting in human dwellings and cattlesheds, respectively. Some seasonal fluctuations in the month-wise person hour density (PHD) of *An. culicifacies, An. fluviatilis* and *An. annularis* were observed. The highest density of *An. fluviatilis* was observed between October and February, whereas the highest density of *An. culicifacies* and *An. annularis* was observed between May and September and the lowest during October–April.
- A Phase-IIIb open label trial to assess the safety, tolerability and efficacy of dihydroartemisinin/piperaquine (Eurartesim®) in Indian children and adolescent patients with acute uncomplicated *P. falciparum* malaria was carried out. This was a multicentre, phase-IIIb, single arm trial to assess the safety, tolerability and efficacy of Eurartesim oral film coated tablet formulation (160/20 mg or 320/40 mg PQP/DHA) in children and adolescent patients with acute uncomplicated *P. falciparum* malaria. A total of 100 patients fulfilling screening criteria were enrolled in the study at two study sites, RIMS, Ranchi and Wenlock Hospital, Mangalore. RIMS, Ranchi site enrolled 66 patients. Each patient was followed up until day 63 (±3 days). Patients were admitted during the first three days of study treatment; the follow up visits were performed on an outpatient basis on Day 7, Day 28, Day 42 and Day 63. No positivity was observed on Day 3 of the administration of Eurartesim®. All the patients were well-tolerated to Eurartesim® and no adverse effect was observed during the study period so for. Enrolment has been completed and follow up of the cases is also completed.
- Monitoring of the therapeutic efficacy of ACT (Artesunate + sulphadoxine and pyrimethamine) against uncomplicated *P. falciparum* malaria was carried out at Kurdeg PHC of Simdega district, Jharkhand state. All the malaria positive cases were susceptible to ACT.
- Filariasis survey was carried out in four districts of Jharkhand state—Dhanbad, Garhwa, East Singhbhum and Lohardaga. The districts are dominated by Munda, Ho, Oraon, Kharwar, Chero and Kharia tribes. The microfilaria rate was 5.03% in Baghmara PHC of Dhanbad district, 4.07% in Nagaruntari PHC of Garhwa district, 3.03% in Musabani PHC of East Singhbhum and 3.03% in Bhandra PHC of Lohardaga district. All the districts were in hotspot area. In total nine rounds of MDA was carried out in Dhanbad, Garhwa and East Singhbhum districts and 10 rounds of MDA was carried out in Lohardaga district. The study highlights the problem of filariasis in the Jharkhand state and it requires urgent intervention to curtail the disease.
- To facilitate early diagnosis and prompt treatment a Malaria Clinic is functioning at NIMR, Field Unit, Itki, Ranchi. All the cases from Itki PHC and TB Sanatorium hospital were diagnosed. A total of 264 patients attended the Malaria Clinic during the year 2016–17, out of which 11 cases were positive for malaria. Of these, 2 cases were positive for *P. vivax* and 9 for *P. falciparum*. Overall SPR was 4.16%, SFR 3.4% and *Pf*% was 81.81%. One *P. falciparum* positive patient showed gametocyte in the peripheral blood.
- A Filaria Clinic is also functioning at IDVC Field Unit, Itki, Ranchi. A total of 30 patients of filariasis attended the clinic during the year. Most of the cases were of old cases of filariasis. These cases were with acute manifestation of filariasis starting from hydrocele to elephantiasis. One case of epididymo-orchitis was observed. Four patients had multiple manifestations (13.33%).
- Support provided to NVBDCP and the State Health Programme with reference to the following activities: Therapeutic efficacy of

antimalaria drug ACT; Capacity building in the field of malaria entomology, microscopy and surveillance; Insecticide resistance monitoring in Simdega and West Sighbhum districts; Quality control of laboratory services (Diagnosis of malaria and filariasis, and training for Transmission Assessment Survey (TAS).

- Six health education camps and IEC activities were carried out in villages (Jarwadih, Dumargarhi, New Torang, Old Torang, Karamtungri and Jonha) of Jonha APHC of Ranchi district, Jharkhand state. The inhabitants of the villages are Munda and the Oraon (the major ethnic groups) and the other remaining ethnic groups were the Lohra, Bedia, Baraik and Kachhap tribes. The role of early detection of malaria cases and prompt treatment was discussed among the tribes. The use of long- lasting insecticide-treated nets (LLIN) for protection against mosquito and malaria was discussed among the tribal people. Role of RDT and ACT combination therapy was discussed. Lectures and demonstrations regarding malaria and use of LLINs were delivered to the tribal people. All the tribal people were advised to go to the PHC for detection of malaria cases instead of going to local healer and witchcraft.

5.9 Raipur (Chhattisgarh)

- Monitoring of impact of insecticide resistance in malaria vectors on Effectiveness of combination of IRS and LNs in 80 clusters (villages) with population of 75,000 in Keshkal block of Kondagaon district, Chhattisgarh.
- Field evaluation of efficacy, fabric integrity and acceptability of Olyset LNs in 10 villages of Kanker (6) and Balod (4) districts of Chhattisgarh state.
- Susceptibility tests were carried out in all 27 districts of the state. Tests were carried out against the insecticide treated papers of DDT (4%) and alpha-cypermethrin (0.05%). These insecticides have routinely used in malaria control programme in the state. Besides these, the tests were also carried out against malathion (5%) (an organophosphate insecticide), two more dosages of alpha-cypermethrin (0.01) and (0.1%), deltamethrin (0.05%), permethrin (0.75%) and bendiocarb (0.1%) (a carbamate insecticide). *Anopheles culicifacies* was tested against, DDT (4%) in 15 districts, malathion (5%) in 18 districts, alpha-cypermethrin (0.05%) in 11 districts, deltamethrin (0.05%) in 26 districts and bendiocarb (0.1%) in 21 districts. It was also tested against alpha-cypermethrin (0.01%) and (0.1%) and permethrin (0.75%) in 16 and 5 districts, respectively.
- Monitoring of therapeutic efficacy of ACT against uncomplicated *P. falciparum* in Antagarh CHC, District Kanker, Chhattisgarh.
- Provided technical support to the national malaria programme by cross-checking of malaria slides received from various districts of Chhattisgarh state.
- Imparted training in malaria and its control to M.B.B.S. students from Govt. Medical College, Raipur, M.B.B.S. students from AIIMS, Raipur and B.H.M.S. students of Maharana Pratap Homoeopathic Medical College and Hospital, Raipur.
- Refresher training course in malaria microscopy to Laboratory Technicians of 14 districts of Chhattisgarh state.
- Participated in monthly review meeting of Chief Medical Officers/District Malaria Officers organised by the State Health Secretary at Raipur. ❑

Research Support Facilities

6

6.1 Animal House Facility

The animal house facility at NIMR is maintained as per the CPCSEA guidelines. Majorly, it maintains small laboratory animals like balb/c mice and New Zealand rabbits for research activities such as screening the antimalarials, parasite maintenance, insectary maintenance, immunological studies, *etc.* The projects involving the animals are only undertaken after their approval by the Scientific Advisory Committee (SAC) and Institute Animal Ethics Committee (IAEC) of the Institute. The animal facility has dedicated technical staff for its smooth functioning. The new animal house is under construction and to be completed soon.

6.2 Repository of Biological Materials

6.2.1 Mosquito species

The details of mosquitoes being maintained in the NIMR Insectary are furnished in Table 1.

6.2.2 Malaria Parasite Bank

The Malaria Parasite Bank (MPB), established in the year 1992, is functioning as a National Resource facility and is involved in the collection of field/ clinic *Plasmodium* isolates. The bank has a variety of human and non-human plasmodia species collected over a period of last 26 years. The distribution of major parasite species and their state-wise location of collection for the last 10 years are shown in Figs. 1 and 2, respectively. The routine activities

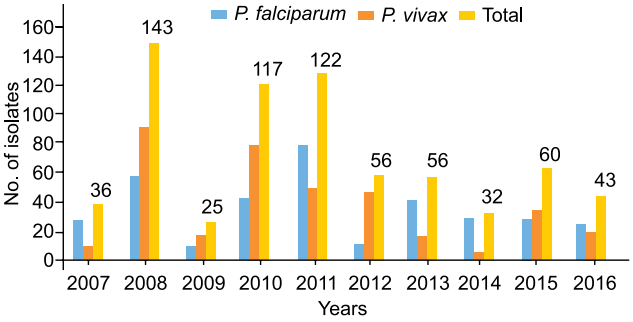


Fig. 1: Number of *Plasmodium* isolates preserved in MPB since last 10 years.

Table 1. Details of mosquito species being maintained in the Insectary of NIMR

Species	Strain/Origin	Year of establishment	Isolated from
An. stephensi	Sonepat	Since 2000	Haryana
	Nadiad	2007	Gujarat
	Panjim	2009	Goa
	Alwar	2013	Rajasthan
An. culicifacies	Burari	2013	Delhi
	Rameswaram	2013	Tamil Nadu
	Dehra	2013	Himachal Pradesh
	Dadri	2013	Uttar Pradesh
	Beel Akbarpur	2013	Uttar Pradesh
	Manki	2013	Uttar Pradesh
	Raipur	2013	Chhattisgarh
Cx. quinquefasciatus	RR Permethrin (0.05%)	1999	Mewat (Haryana)
	RR Lambdacyhalothrin (0.05%)	1999	Mewat (Haryana)
	RR Deltamethrin (0.05%)	1999	Mewat (Haryana)
	RR Malathion (5%)	2000	Mewat (Haryana)

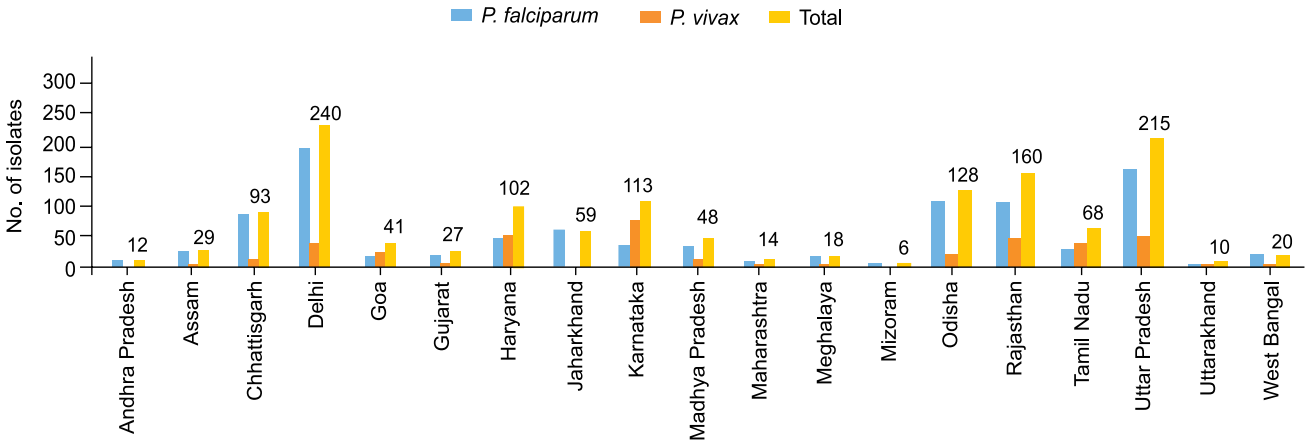


Fig. 2: State-wise distribution of collected *Plasmodium* isolates preserved in MPB since last 10 years.

include *in vitro* cultivation of *P. falciparum*, characterization of the isolates for susceptibility to different antimalarials, cryopreservation and revival of adapted and non-adapted cultures. Parasite isolates of all five human malaria parasite species, malaria positive and negative sera; and non-human malaria parasites in cryopreserved status (Table 2) and in their respective animal hosts, wherever possible, are currently being maintained in the MPB.

Table 2. Non-human Malaria Parasites collected in the Parasite Bank

Parasite species		CQ susceptibility
Simian malaria	*P. cynomolgi bastianelli*	Not done
	P. knowlesi	Not done
	P. fragile	Not done
Avian malaria	*P. gallinaceum*	Not done
	P. relictum	Not done
Rodent malaria	*P. berghei*	CQ-Resistant
	P. berghei	CQ-Sensitive
	P. berghei ANKA	Not done
	P. berghei (NK65)	Not done
	P. chabaudi	Not done
	P. yoelii nigeriensis	Not done

Screening of drug sensitivity status

Since 1993, a total of 287 *P. falciparum* samples from different regions were tested for the sensitivity to chloroquine (CQ) and 187 (65%) were found to be resistant to CQ.

Cultivation of pre-erythrocytic stage of *P. vivax in vitro*

For the first time in India, *P. vivax* pre-erythrocytic schizonts (liver stage) were developed in hepatoma cell line using the facilities of Parasite Bank. Mosquitoes were fed on infected blood through artificial membrane feeding apparatus and the fed mosquitoes were dissected on appropriate days for oocyst and sporozoites. These sporozoites from artificially fed mosquitoes were used for inoculating the hepatocytes/hepatoma cell line for the development of pre-erythrocytic stage parasites.

Cultivation of erythrocytic stage of *P. vivax in vitro*

Efforts have been made to cultivate and adapt erythrocytic stages of *P. vivax in vitro*, like *P. falciparum* in different combination of media and culture conditions, with little success. A low level parasitaemia could be maintained up to 52 days and growth of the parasites was observed for 2–3 cycles. This short-term culture system standardized in Parasite Bank can be used for screening of antimalarials *in vitro*.

Supply of biological materials

Providing malaria parasites to the scientific community (various institutes, universities and other research organiations) has been one of the major activities of the Parasite Bank. The biological materials can be requested from any researcher against an online payment.

The details of various isolates available and corresponding charges are mentioned in Table 3, whereas the characterized isolates are mentioned in Table 4. The number of parasite isolates supplied by the MPB and the amount of monetary resource generated (in Rupees) are reflected in Tables 3 and 4, respectively.

Table 3. Isolates available in the Parasite Bank and their corresponding charges (Rupees)

Biological materials	Charges
P. falciparum adapted and characterized for chloroquine sensitivity	₹ 2000/1 ml vial (cryopreserved or running culture)
P. falciparum characterized for erythrocyte invasion phenotype & cytoadherence	₹ 2000/1 ml (cryopreserved or running culture)
P. falciparum cultivated and adapted *in vitro*	₹ 1500/1 ml (cryopreserved or running culture)
P. falciparum cultivated *in vitro* (short-term cultivation / non-adapted	₹ 1500/1 ml (cryopreserved or running culture)
P. falciparum (original stock)	₹ 1500/1 ml (cryopreserved)
P. vivax (original stock)	₹ 1500/1 ml (cryopreserved)
P. falciparum culture supernatant (spent media)	₹ 750/250 ml (frozen)
Serum / Plasma from *P. falciparum* or *P. vivax* infected blood	₹ 500/1 ml vial (cryopreserved)
Non-human plasmodia	₹ 750/1 ml vial (cryopreserved)
Sera / Plasma from non-human Plasmodia infected animal	₹ 100/1 ml vial (cryopreserved)

Note: (1) The charges exclude packaging and transportation charges which are to be arranged and borne by the individual requesting; (2) The biological materials listed above will be supplied on first-come first-served basis; and (3) The payment has to be made online to Canara Bank, CCRT, Sector 7, Dwarka, New Delhi (RTGS–2948201010111; IFSC–CNRB0002948).

Table 4. Details of characterized *P. falciparum* parasites

Parasite isolate characteristics	Number
Adapted isolates susceptible to chloroquine	54
Adapted isolates resistant to chloroquine	52
NF-54, an infective gametocytes producing strain of *P. falciparum*	1
3D 7A : A clone of NF-54	1
Field isolates which can invade trypsin-treated erythrocytes	3
Field isolates which can invade neuraminidase-treated but not trypsin-treated erythrocytes	3
Field isolates which can invade normal erythrocytes but not neuraminidase- or trypsin-treated erythrocytes	3
Field isolates which can invade both neuraminidase-treated and trypsin-treated erythrocytes	5
Field isolates that can form rosettes	3
Field isolates which can bind to CSA	1
Field isolates which can bind to CD36	9
Field isolates which can bind to ICAM-1	2

6.3 Library and Information Centre

The Library and Information Centre at NIMR is a resource centre which provides an access to literature and documentation in the field of malaria and other vector borne diseases. It serves as a bank of information.

The Library and Information Centre of NIMR endeavours to acquire process, organize and disseminate global information to fulfil the information needs of the administrators, policy makers, scientists, research scholars, outside visitors and foreign delegates. This Centre uses *e-granthalaya* software package, which consists of modules on acquisition, cataloguing, circulation, serial, web OPAC, membership and article indexing. All the collections of this resource centre are completely computerized and indexed.

Library Timings

Monday to Friday— 0900 to 1730 hrs

Library collections

Books	5100
Bound journals	5160
Journals (Online)	25
Newspapers	14
Magazines	20
CDs/DVDs	40
Reprint documents	350
Theses	42
Reports (National and International)	135

Special collections

- Census of India publications
- WHO publications

- National Survey Reports on Malaria and other Vector Borne Diseases
- NIMR publications

Library services

- Circulation of Books
- Inter Library Loan
- Document Delivery
- Reference and Information Services
- Citation Analysis
- Wi-Fi Internet Access Facility
- Reading Hall
- Photo Copying
- Scanning

E-Resources (Online Journals) Services

- ERMED Consortium
- JCCC@ICMR Consortia
- ICMR e-Consortia Journals
- NIMR Subscribed online journals

Documentation services

- New arrivals/List of Addition of books
- Abstract on Malaria & other Vector Borne Diseases
- Health News Alert on Malaria & other Vector Borne Diseases
- Annotated Bibliography of NIMR (Research publications)
- Current Awareness Service of Journals

Apprentice training

The NIMR Library & Information Centre trains and empowers students of library and information discipline by recruiting apprentices for one year. In the year 2016, three apprentice trainees were recruited and trained successfully.

Resource sharing

Library and Information Centre is an active member of Developing Library Network (DELNET) and shares its resources with 5535 member libraries and information centres across the Globe. ❑

Inter-Institutional Collaboration

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In addition to Intramural projects, the Institute collaborated with different national and international centres/agencies for wide coverage, protection and effective control of malaria and other vector borne diseases:

1. Development of molecular tools for detection of asymptomatic malaria: Intramural.
2. A neuro-olfactory transcriptomic analysis in the mosquito *Anopheles culicifacies,* funded by ICMR.
3. Ecology and distribution of *Aedes albopictus* and *Ae. aegypti* with special reference to *albopictus* subgroup species of the subgenus *Stegomyia* in Kerala, India in collaboration with VCRC, Puducherry.
4. Center for the Study of Complex Malaria in India (CSCMi) under the International Centers of Excellence for Malaria Research (ICEMR) programme in collaboration with the New York University and the Pennsylvania State University (NIH project).
5. A survey to assess the infectious reservoir of *Plasmodium* infections and to monitor the efficacy of antimalarial medicines in East Garo Hills district, Meghalaya and Udalgiri district, Assam, Northeast India, funded by ICMR-NE.
6. Monitoring the therapeutic efficacy of antimalarial medicines in India in collaboration with NVBDCP, Delhi and State health authorities of Tripura, Mizoram and Meghalaya, funded by GFATM/NVBDCP.
7. Biochemical and molecular analysis of G6PD deficiency in selected sites of India: Intramural.
8. Study the altered substrate specificity by changing the charge of succinyl-CoA-synthetase of malaria parasite as drug target, funded by Council of Scientific and Industrial Research (CSIR), Govt. of India.
9. Vector surveillance for ZIKAV/JEV in selected high risk areas of India and isolation of Zika virus in *Aedes aegypti* from dengue endemic zones of Delhi: Intramural.
10. Studies on health impact assessment of Sardar Sarovar project in command area of Rajasthan in collaboration with State health department, CE Narmada and SE Narmada, Rajasthan, funded by NVDA, Rajasthan.
11. Phase-II field evaluation of a long-lasting insecticidal net coated with chlorfenapyr and alphacypermethrin (Interceptor G2 of BASF) against natural population of *Anopheles culicifacies* in experimental huts in District Kheda, Gujarat, funded by WHOPES.
12. Phase-II and III field evaluation of the efficacy and residual activity of Fludora fusion 562.5 WP-SB (Clothianidin 50% + deltamethrin 6.25%) for indoor residual spraying for malaria vector control in Gujarat state, India, funded by WHOPES.
13. Phase II and III evaluation of the efficacy and residual activity of Sumi Shield 50% WG (clothianidin 50%) for indoor spraying for malaria vector control in Karnataka State, India, funded by WHOPES.
14. Efficacy study on uses of innovative ovitraps: Intramural.
15. Studies on the breeding potential, breeding habitats, knowledge and prevention strategies for the control of dengue vector, *Aedes aegypti* in District Ghaziabad of UP: Intramural.
16. Association of delayed haemolysis and intravenous artesunate therapy in severe malaria: Intramural.
17. Evaluation of rapid diagnostic tests for dengue, funded by ICMR. ❑

Human Resource Development

8

8.1 Ph.D. Programme

NIMR provides facilities for pursuing Ph.D. degrees to the students. The Institute is affiliated to the Goa University, Goa; Kumaun University, Nainital; Maharshi Dayanand University, Rohtak; IGNOU, New Delhi; Amity University, Noida; University of Calcutta, West Bengal; Garhwal University, Uttarakhand; University of Delhi, Jamia Millia Islamia, New Delhi, Delhi Technical University, Delhi; NIRMA University, Ahmedabad; and Guru Jambheshwar University, Hisar.

8.2 Students in Ph.D. Programme

Following students are completing their Ph.D. degree under the supervision of NIMR scientists: Ms Manoswini Dash, Ms Sonalika Kar, Ms Preeti Chaudhary, Mr Nitin Bhardwaj, Md Zohaib Ahmed, Mr Sandeep Kumar, Ms Sarita Kumari, Ms Preeti Kumari, Ms Swati Sinha, Ms Renuka Gahtori, Ms Swati Rani, Ms Reva S Thakur, Mr Vikky Kumar, Mr Bijendra Kumar, Ms Poonam Singh, Mr Jagbir, Ms Kavita Kadian, Ms Ritu Rawal, Ms Nisha Singh, Ms Alka Rani, Ms N Elamathi, Mr KMN Prasad, Mr Atul, Ms Jyoti Rani, Ms Vandana, Mr Rahul Pasupreddy, Ms Bhumika Kumar, Ms Seena Kumari, Ms Charu, Mr Kapil Vashisht, Ms Shobhna Mishra, Ms Taranjeet Kaur, Ms Gunjan Sharma, Ms. Sonal Kale, Ms Ankita Sindhania, Ms G Sri Lakshmi Priya and Ms R Sangamithra.

8.3 M.Sc./B.Tech Projects/Dissertations

The Institute also provides facility for fulfilment of Master's degree in Life Sciences/Biotechnology/ Bioinformatics, *etc.*

Several M.Sc. students, namely Mr Aditya Sharma, Ms Nisha Tiwari, Mr Mohana Shukla, Ms Neha Chadha, Ms Hena Fatemah and Ms Meghna Chatterjee successfully completed their projects/ dissertations under the supervision of NIMR scientists.

8.4 Seminars/Conferences/Workshops/ Training courses/Meetings organized

NIMR has conducted regular training programmes as under:

Dr Dutta GDP

- One-day orientation training for the students of III year MBBS from the Govt. Medical College, Raipur and 14 students of 4th year BHMS from the Maharana Pratap Homoeopathic Medical College and Hospital, Raipur were imparted training on various aspects of vector borne diseases and their control.
- Refresher training to Laboratory Technicians in malaria microscopy was imparted to 39 Laboratory Technicians from 9 districts, posted in 10 CHCs, 11 PHCs, and 3 Hospitals in two batches from 14–18 March and 4–8 April 2016.

Dr Ghosh SK

- Organized XI Joint Annual Conference of ISMOCD & IAE and presented paper entitled "Genotyping of *Plasmodium vivax* samples by using minisatellite marker" at Bengaluru from 10–12 June 2016.

Dr Nagpal BN

- Organized Induction Training for District

Glimpses of Induction training for District Malaria Officers

Glimpses of Training programmes to control vector borne diseases

Malaria Officers of Madhya Pradesh (Batch-2) funded by the State Health Department (MP) at NIMR, New Delhi from 2 May–10 June 2016.

- Organized Training to Master Trainer to control Vector Borne Diseases in Simhasta Mela in Ujjain, Madhya Pradesh funded by the Health Department (MP) at NIMR, New Delhi during April–May 2016.

Dr Kumar Ashwani

- Organized DST SERB Project Assessment Committee meeting at NIMR FU, Goa from 12–14 December 2016.

Dr Mishra N

- Organized Orientation meeting under the project entitled "Monitoring the therapeutic efficacy of antimalarial medicines in India" in

collaboration with Senior Regional Director(s), State Programme Officer(s) and NVBDCP officials at CHC Block, Gangoh (Saharanpur) from 25–27 July 2017, and at Regional Office for Health & FW, Govt. of India, Kolkata on 4 August 2016.

- Organized Orientation meeting of the project entitled, "To study the factors responsible for treatment failure to artemisinin therapy in *P. falciparum* malaria patients in selected study sites in India (CSCMi)" at NIMR, New Delhi on 2 August 2016.
- Organized Launch meeting of the Project entitled, "A survey to assess the infectious reservoir of *Plasmodium* infections and to monitor the efficacy of antimalarial medicines in East Garo Hills district, Meghalaya and Udalguri district, Assam, Northeast India" at Guwahati, Assam on 19 August 2016. Participants included State Programme Officers & Senior Regional Directors of Assam & Meghalaya states and District health officials. ❑

Research Papers Published
(January-December 2016)

9

1. Akhtar N, Nagpal BN, Kapoor N, Srivastava A, Gupta Hardev P, Saxena Rekha, Shamim Arshad, Vikram Kumar, Gupta Sanjeev Kumar, Singh VP, Dev Vas, Nanda Nutan, Valecha Neena. Impact of ecological and climatic changes on vectors of malaria in four Northeastern States of India. *Ind J Ecol* 2016; *43*(1): 1–15.
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Chapter in book

1. Dhiman RC. Scenario of malaria and dengue in India: Way forward in the Chapter No. 6 of Climate change and human health scenario in south and southeast Asia; Part of the series advances in Asian: Human-environmental research edited by Akhtar R, published by Springer International Publishing, Switzerland 2016; p. 91–7.

WHO Handbook

1. Dr Kumar Ashwani wrote a Handbook on "Vector surveillance and control at Points of Entry" which is available online on WHO Website in English, Chinese, Russian, Spanish and French *(http://www.who.int/ihr/publications/9789241549592/en/)*.
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Other Activities 10

10.1 Information Education and Communication (IEC)

For creating awareness about vector borne diseases (VBDs) in school children, a lecture-cum-discussion session was organized for all the sections of 9th Class at SBV No. 2, Palam Enclave, Delhi on 22nd July 2016. Information regarding vector borne diseases and prevention, and means of personal protection methods were provided to them. Students were informed about sites/places of mosquito breeding. Being July the month of rainy season in north India, students were made aware about the preference of vector mosquitoes (malaria and dengue) that breeds in fresh water/ rain water in discarded pots, tyres, drums, coconut shells, *etc.*

Awareness programme about vector borne diseases (VBDs) in school children through a lecture-cum-discussion session organized for Class IX at SBV No. 2, Palam Enclave, Delhi on July 22, 2016.

Disseminating information about dengue and chikungunya to patients attending OPD of NIMR on September 28, 2016.

10.1.1 Documentation Cell

Number of tasks were carried out in this cell:

- Updating of various information regarding the Research Projects (intramural and extramural) such as their status, *i.e.* ongoing or completed and or extension period (if any) granted, budget/grant received and collaboration detail for projects undertaken by NIMR. These were carried out on the basis of inputs provided by individual principal investigators PI/Co-PI as well as minutes received from SAC meeting for the year 2016–17.
- Compiled / enlisted Intramural projects approved by the 36th SAC meeting.
- WHO Consultant for GLP Review, Dr Grahm Small visited the Documentation Cell and observed our Documentation system and services *etc.* and noted down useful information.
- Updating of research publications list and their compilation for the year 2016–17.

The following services were provided to various Divisions of NIMR by the Documentation Cell:

- List of ongoing projects at NIMR's Field Units, name of PI/Co-PI, name of Unit Incharge, was provided to AO, NIMR for the purpose of allocation of room for NIMR Field Unit at NIRTH main building.
- Document for Application under 3CF-1 & 3CF -2 for renewal of certificate, *i.e.* Application

Form from Scientific and Industrial Research Organization for approval under section 35 of the Income Tax Act were prepared which included : (i) Trust Deeds/Deed of registration/ Memorandum & articles of association; (ii) Plants & machinery; (iii) Land & building along with cost of acquisition; (iv) Research facility/ assets; (v) Details of scientific research or social services, statistical research, new projects and patents, *etc.*

- List of New Projects (July to December 2015) was provided to Library Incharge for preparation of *Plasmodium* Newsletter for the year 2016.
- Informations were provided to Mr Arun Gaur, Store staff, pertaining to the details of R&D Programme/Project and Research Programme initiated during last 5 years, details of proposed R&D work and Research Programme initiated during last 5 years, list of Ph.D. staff and PG staff and other staff, Number of papers published during last two years, Number of patents Indian/ Foreign during last two years and any award won by Institute for renewal of Custom Duty Exemption Certificate (expiry on 31 August 2016).
- Allotted project IDs to New Projects Extramural/ Intramural.
- Information on grants received from external funding agencies, bilateral interagency programmes, participation in National Programmes during 12th Plan (2012-17) and details on intramural projects funded by ICMR were provided to Dr RC Dhiman on 28 November 2016.

10.1.2 Photography and Videography

In the photography section photography work was carried out on various occasions/meetings/ trainings/workshops/field surveys/functions held at NIMR and ICMR.

Still Photography

Following photography works were carried out during various meetings/workshops/functions/ scientific visits, *etc.*

- Month-wise-photography of *Swachh Bharat Abhiyan*.
- Photography of different scientific works undertaken in various labs of NIMR.
- ICMR-Cancer registry report at ICMR held in May 2016.
- NIMR & ICMR *Yoga Diwas* held on 21 June 2016.
- WHO supported refresher training of Malaria Microscopists held from 22 November to 2 December 2016.
- Induction Training for District Malaria Officers of Madhya Pradesh from 25 April to 3 June 2016.
- WHO supported refresher training of Malaria Microscopists held from 12–16 December 2016.
- Photography of Hindi *Pakhwada* celebration at NIMR.
- Dissemination workshop on ICMR studies on newer contraceptive methods at ICMR, in November 2016.
- ICMR-SAMRC meeting on Research capacity strengthening held from 27–28 March 2017.
- MCD and DHRD training for skill up-gradation/ Hands on training programme on lab diagnosis of malaria held at NIMR from 20–24 February 2017.
- MoU execution at ICMR on 7 February and 12 February 2017.
- Photography of other activities organized at NIMR.

Video Recording

Following video recordings along with editing and adding special effects were carried out on the occasions of various meetings /workshops/ functions and field work activities, *etc.* held at NIMR or other places: (i) *Swachh Bharat Abhiyan;* (ii) *Hindi Phakhwada;* (iii) *Yoga* for health; and (iv) Life cycle of malaria parasites.

Distribution of Video CDs

Video DVDs on Malaria, Dengue, Mosquitoes, Bednets and other related subjects produced at NIMR were distributed to participants in different training programmes organized by NIMR, NVBDCP and NCDC, ICMR. The CDs were also sent to the states and given to interested visitors.

10.1.3 *Swachh Bharat Abhiyan*

Swachh Bharat Abhiyan is a national campaign led by the Government of India to make India, a clean India. This campaign was launched officially by the Government of India on the 145th birth anniversary of the great, Mahatma Gandhi on 2 October 2014, at Rajghat, New Delhi. This campaign aims to accomplish the vision of 'Clean India' by 2 October 2019 the 150th birth anniversary of Mahatma Gandhi.

In this regard, NIMR regularly organizes different activities like *Shramdan*, interactive meetings, public lectures and IEC campaigns. Officials and staff of the Institute actively participate in such activities. Some special mentions are:

- Pledge on cleanliness and hygiene was taken by about 150 staff and scientists of the Institute on 17 May 2016.
- Voluntary *Shramdan* activity was organized on 17 May 2016 and window panes of corridors of 2nd and 3rd floors were cleaned and covered with brown papers (windows facing sunshine) for reduction of sunlight and heat.
- An interactive panel discussion on Hygienic practices to prevent communicable diseases was held at *Anganwadi* and CGHS, Wellness Centre, Mansarovar (MS) Park, Delhi, and pamphlets and posters on hygiene practices were also distributed.
- Ayurvedic clinics and 25 other *Anganwadis* (No. 83 to 85 and 92 to 113) situated at MS Park, Shri Ram Nagar and Lalbagh *Jhuggi* area, were also visited for similar activities on 25 May 2016.

Director and staff of the Institute taking pledge on cleanliness and hygiene

Covering of windows facing sunshine with brown papers

Different activities under *Swachh Bharat Abhiyan*

10.1.4 International Yoga Day

Yoga is a 5000-year old physical, mental and spiritual practice having its origin in India, which aims to transform both body and mind. On December 11 in 2014, the United Nations General Assembly declared June 21 as the International Day of Yoga. The declaration came after the call for the adoption of June 21 as International Day of Yoga by the Hon'ble Indian Prime Minister, Shri Narendra Modi during his address to UN General Assembly on September 27, 2014, wherein he stated: "Yoga is an invaluable gift from India's ancient tradition.

It embodies unity of mind and body; thought and action; restraint and fulfilment; harmony between man and nature; a holistic approach to health and well-being. It is not about exercise but to discover the sense of oneness with yourself, the world and the nature".

Yoga session

Yoga Day was celebrated at NIMR premises on 27 June 2016. *Dhyan Yoga* was performed from 1600–1700 hrs. The Director of the Institute chaired the whole programme and scientists, officers and all staff participated in the yoga session. A reputed lecturer of Art of Living and trainer of *Dhyan Yoga* was invited for this occasion. Leading a stress free life was advocated with the help of meditation and Yoga. The staff practiced meditation and some *'Asanas'* of yoga which resulted in a very amazing experience.

10.2 Publication and Information Division

For dissemination of novel scientific information and new knowledge generated on malaria and other vector borne diseases to the scientific as well as general community, the P&I Division of the NIMR continued its diverse activities in the field of publication and information by regularly publishing different periodicals, books, newsletters *etc.*

Journal of Vector Borne Diseases

The *Journal of Vector Borne Diseases* is a peer reviewed, open access, quarterly published biomedical journal dedicated to the publication of original research contributions in the field of vector borne diseases such as malaria, filaria, Japanese encephalitis, dengue, chikungunya, Crimean-Congo haemorrhagic fever (CCHF), leishmaniasis, trypanosomiasis, *etc.* with the aim of their control and prevention. This journal superceded the *Indian Journal of Malariology* in 2003 which was started long back in 1947. The journal is indexed by the major abstracting agencies like Science Citation Index Expanded, PubMed, Scopus, Scimago Journal Ranking, DOAJ, *etc.*

All the issues (four issues a year) of the journal were published regularly and timely, during the reporting period. The full articles of the journal can be accessed online through Institute's website (*http://nimr.org.in/jvbd.html; www.jvbd.org/*) as well as PubMed, DOAJ and other resources. At present, archives from the year 2003 are available on the website. The print version is available on subscription basis with discount to the scientific community and agencies. There is regular improvement in the standard and quality of journal as evidenced by the Impact factor released by the Journal Citation Reports. The Impact factor for the year 2016 was 1.19 [Clarivate Analytics (previously Thomson Reuters), 2017].

Malaria Patrika

Malaria Patrika is a popular *Hindi* magazine launched in 1993 with four issues in a year. The Division publishes the issues of *Malaria Patrika*, for educating the local as well as scientific community on malaria and spreading awareness on vector borne diseases and their control. The issues published in 2016 primarily focused on different ways of malaria prevention, intervention strategies and problems of insecticide resistance in malaria vectors, *etc.*

Plasmodium Newsletter

Plasmodium Newsletter of the Institute, published biannually, highlighted the recent research investigations and advancements in the field of malaria, focusing primarily on the news related to malaria drugs, diagnostic tools and techniques, and reported major activities of the Institute and its Field Units during the reporting period.

Annual Report

In addition to above, the Division also published Annual Report of the Institute (NIMR) for the financial year 2016–17. The Annual Report included all the research activities of the Institute, publications

of scientists and researchers, details of inter-institutional collaborations, intramural/extramural funded projects, and other activities of the Institute.

10.3 Seminars/Conferences/Workshops/ Training courses/Meetings attended

Eapen Alex

- Attended and presented a research paper in XI Joint Annual Conference of Indian Society for Malaria and other Communicable Diseases & Indian Association of Epidemiologists at Bengaluru, India from 10–12 June 2016.
- Attended Sensitization workshop on GLP at New Delhi, India from 17–18 October 2016.
- Attended and presented the research findings in Annual SAG meeting of International Centers of Excellence in Malaria Research (ICEMR) of NIH at Atlanta, USA on 13 November 2016.
- Attended and presented a research/scientific paper in '65th Annual Meeting of American Society of Tropical Medicine and Hygiene (ASTMH)' at Atlanta, USA from 13–17 November 2016.
- Attended Malaria Elimination Group Eleventh (MEGXI) meeting organized by University of California San Francisco (UCSF) on Global Health Group's Malaria Elimination Initiative at Vivanta Taj Fisherman's Cove Hotel, Covelong, Tamil Nadu, India from 6–9 December 2016.
- Attended and presented a research paper in 13th Conference on Vectors and Vector-Borne Diseases at Chennai, India, from 27 February to 1 March 2017.

Das R

- Attended conference on XI Joint Annual Conference of ISMOCD & IAE and presented paper entitled "Genotyping of *Plasmodium vivax* samples by using minisatellite marker" at Bengaluru from 10–12 June 2016.
- Attended training on fourth good laboratory practice (GLP) course for GLP inspectors at Indian Habitat Centre, New Delhi, from 19–23 December 2016.

Dixit RK

- Attended 27th annual molecular parasitology meeting & presented a poster on "Engineering nucleotide specificity of Succinyl CoA Synthetase in Blastocystis and *P. falciparum*: The emerging role of gatekeeper residues" at Marine Biological Laboratory in Woods Hole, MA (USA) from 18-22 September 2016.

Dutta GDP

- Attended a meeting on Preparatory activities for vector-borne and water-borne diseases in monsoon season which was chaired by Principal Secretary, Health, Govt. of Chhattisgarh held at Raipur on 13 May 2016.
- Attended a meeting on Control of vector-borne diseases held at Raipur on 18 May 2016.
- Attended a workshop on PCR held at Regional Leprosy Training and Research Institute, Raipur on 30 May 2016.

Ghosh SK

- Attended meetings on Malaria Elimination Framework in Karnataka from 7–26 November 2016.

Kumar Ashwani

- Presented plenary talk 'Malaria Research and Control in India' at the 47th conference of the Society for Vector Ecology at Alaska, USA from 11–14 September 2016.
- Attended Vector Control Advisory Group meeting held at WHO HQs, Geneva, Switzerland from 6–9 November 2016.
- Attended International Conference of Entomology at Punjabi University, Patiala from 3–5 December 2016.

Mishra N

- Attended Observance of World Malaria Day at Hotel Shangri-La's Eros, New Delhi on 25 April 2016.
- Attended Innovation and Translation Research (ITR) meeting on "Review of Technologies for Public Health Use" at ICMR HQs, New Delhi on 20 May 2016.

- Attended meeting on "Women's health issues: Broadening the mandate beyond maternal health" at ICMR HQs, New Delhi on 27 May 2016.
- Attended "XI joint Annual Conference of ISMOCD & IAE" at Bengaluru and delivered invited talk on "Emerging tools and techniques for measuring antimalarial drug resistance" during 10–12 June 2016.
- Attended and presented the progress of study on "Therapeutic efficacy of antimalarial medicines in India" under the Chairmanship of DGHS, Nirman Bhawan, New Delhi on 21 June 2016.
- Attended meeting on International cross border districts malaria elimination situation analysis at Vivanta, New Delhi from 22–23 June 2016.
- Attended meeting on "Antimalarial drug resistance: Time to act" on Technical Advisory Committee (TAC) of NVBDCP under the Chairmanship of DGHS, MoHFW at Nirman Bhawan, New Delhi on 1 July 2016.
- Attended and presented the Updated status of project "Monitoring the therapeutic efficacy of antimalarial medicines in India" at review meeting of NE states under IMCP-3 at Guwahati, organized by NVBDCP, New Delhi from 14–15 July 2016.
- Expert Member of Initial Screening Committee (ISC) of Technology Development Board (TDB), Department of Science & Technology, Government of India to facilitate up-scaling and commercialization of new technologies in the country on 29 July 2016.
- Attended "Second bi-regional meeting of Asia-Pacific on Malaria drug resistance monitoring networks organized by WHO at Bangkok from 24–26 October 2016.
- Attended Joint International Tropical Medicine meeting (JITMM 2016) and delivered Invited talk on "Antimalarial drug sensitivity and resistance in India" during 6–7 December 2016.
- Attended National Malaria Elimination Task Force meeting under the Chairmanship of DGHS at Nirman Bhawan, New Delhi on 27 December 2016.
- Invited talk on "Phytochemicals for antimalarial drug resistance: Where do we stand?" under National Conference on Development and advancement in conservation, propagation and sustainable utilization of medicinal plants (DSUMP 2017) at Auditorium, Gautam Buddha University on 20 January 2017.
- Attended "Stakeholders' consultation meeting for Preparation of concept note (2018–20) for Global Fund Grant" at Nirman Bhawan, New Delhi on 13 February 2017.
- Invited talk under Induction Training for District VBD Consultants on "Monitoring therapeutic efficacy of antimalarials" at NIMR, New Delhi on 20 March 2017.

Valecha N

- Attended meeting with Health Secretary, State of Punjab for malaria elimination at Chandigarh on 12 April 2016.
- Attended as Guest of Honour in the Workshop on Prevention and Control of Vector Borne Diseases at India Habitat Centre, New Delhi on 18 April 2016.
- Attended meeting with Hon'ble Health Minister, Delhi to Review dengue situation at Delhi Secretariat on 28 April 2016.
- Attended meeting to Review dengue situation in Delhi under Chairmanship of Hon'ble Union Minister of Health and Family Welfare at Nirman Bhawan, New Delhi on 29 April 2016.
- Attended Chaired session "Emerging challenges in parasitic infections" CME-cum-workshop on emerging infections in India at AIIMS, New Delhi on 21 April 2016.
- Attended Presentation on "Implementation research to strengthen malaria elimination" in 23rd Scientific Advisory Group (SAG) meeting of ECD at ICMR HQs, New Delhi on 25 April 2016.
- Attended Expert Group meeting for Malaria in Pregnancy at Taj Vivanta, New Delhi on 5 May 2016.
- Attended Asia Pacific Malaria Elimination Network (APMEN) Malaria Programme Directors and National Experts and Asia Pacific Leaders Malaria Alliance (APLMA) Senior Officials meeting at Bangkok, Thailand from 12–13 May 2016.

- Attended meeting between NIMR and RIMS to formalize and strengthen the collaboration at RIMS, Ranchi on 17 May 2016.
- Attended Plenary lecture on "Changing scenario of malaria treatment with special emphasis on drug resistance" in XI Joint Conference of ISMOCD and IAE at Bengaluru on 10 June 2016.
- Attended Expert Group meeting to Develop a roadmap for *Wolbachia* based vector control strategies for *Aedes* mosquitoes at ICMR HQs, New Delhi on 17 June 2016.
- Attended as Guest of Honour in the meeting on 'International cross border districts malaria elimination situation analysis at Hotel Taj Vivanta, New Delhi on 22 June 2016.
- Attended meeting with Secretary DW&S on Issues related to dengue at Paryavaran Bhawan, CGO Complex, New Delhi on 12 July 2016.
- Attended Group discussion on Proposals on basic studies in malaria entomology at Osmania University and Discussion for animal facility at National Institute of Nutrition, Hyderabad on 18 July 2016.
- Attended Ethics Committee meeting of BL Kapur Memorial Hospital at BLK Hospital, New Delhi on 23 July 2016 and 31 October 2016.
- Attended DST-ICMR workshop on Climate change impact on human health at Hotel Satvic, New Delhi from 25–26 July 2016.
- Attended meeting of Data Safety Monitoring Board (DSMB) at NIMR, New Delhi on 3 August 2016.
- Attended orientation meeting on "Monitoring the therapeutic efficacy of antimalarial medicines in India" at Regional Office for Health & Family Welfare, Kolkata on 4 August 2016.
- Attended meeting of Expert Group on Public Health Pesticides at ICMR HQs, New Delhi on 29 August 2016.
- Attended Planning Committee meeting of the ICMR-MEA India-Africa Health Sciences Summit at Vigyan Bhawan, New Delhi from 1–3 September 2016.
- Attended Malaria Policy Advisory Committee (MPAC), World Health Organization at Geneva, Switzerland from 14–16 September 2016.
- Attended Medicine for Malaria Venture (MMV) Access and Product Management Advisory Committee (APMAC) at Annecy, France from 29–30 September 2016
- Attended Local Research Advisory Committee meeting for research proposals submitted by various faculty members of Govt. Medical College, Amritsar on 8 October 2016.
- Attended Regional Consultation meeting of the WHO Collaborating Centers in the Southeast Asia Region, New Delhi, India from 20–21 October 2016.
- Attended GBD India Vector Borne and Neglected Tropical Diseases Expert Group meeting at the ICMR HQs, New Delhi on 26 October 2016.
- Attended 6th BRICS Health Ministers and Senior Officials meeting at ICMR HQs, New Delhi on 5 December 2016.
- Attended presentation on "Leveraging Existing Platforms for Malaria Elimination" in Malaria Elimination Group Eleventh meeting organized by the UCSF Global Health Group's Malaria Elimination Initiative at Chennai, Tamil Nadu, India from 6–9 December 2016.
- Attended ICMR-WHO national consultation "National Ethical Guidelines for Biomedical and Health Research involving Human Participants" at ICMR HQs., New Delhi on 14 December 2016.
- Attended National Malaria Elimination Task Force meeting under the Chairmanship of DGHS at Nirman Bhawan, New Delhi on 27 December 2016.

Yadav CP

- Attended training on 'Introduction to EpiTM7' organized by the National Institute of Virology (NIV), Pune from 16–19 January 2017.
- Attended workshop on 'Economic evaluation: Introduction, concept and application' organized by the National Institute of Medical Statistics (NIMS), New Delhi from 3–4 March 2017.
- Attended training on 'Advance techniques in surveillance and control of vector borne diseases' organized by the National Institute of Malaria Research (NIMR), New Delhi from 6–31 March 2017.

- Attended 'Induction programme for ICMR scientists' organized by the National Institute of Epidemiology Research, Chennai from 10–14 July 2017.

10.4 Awards/Honours/Nominations

- Dr N Mishra received *Kshanika ICMR Oration Award* (Women Scientist for Biomedical Research).
- Dr Punita Sharma received *ICMR-Post Doctoral Fellowship Award.*
- Dr Rajnikant Dixit received *ICMR-Visiting Fellowship Award.*
- Dr Alex Eapen selected/recognized as *'Fellow of Royal Entomological Society (FRES)'* by resolution of the Council of Royal Entomological Society, UK.
- Dr Alex Eapen received *'National Academy of Vector Borne Diseases (NAVBD)'* award for significant contributions on Environmental aspects of vector-borne diseases' in the 13th Conference on Vectors and Vector-Borne Diseases at Chennai, India from 27 February to 1 March 2017.

10.5 Patent filed

- Mishra N, Kaitholia K, Sharma S, Anvikar AR, Valecha N. A novel molecular diagnostic technique for detecting the different species of *Plasmodium* (PCT/IN2016/000023). ❑

संस्थान में राजभाषा संबंधी गतिविधियां

11

संस्थान में वर्ष 2016-17 के दौरान राजभाषा अधिनियम के अनुपालन के उद्देश्य से राजभाषा हिन्दी के प्रगामी प्रयोग को बढ़ावा देने हेतु कई कदम उठाए गए जिसके अंतर्गत तिमाही बैठकों का नियमित रूप से आयोजन किए जाने के साथ ही, मलेरिया पत्रिका (हिन्दी) का प्रकाशन किया गया एवं राजभाषा विभाग द्वारा लागू प्रोत्साहन योजनाएं कार्यान्वित की गईं जिसके अंतर्गत निदेशक महोदया द्वारा लागू की गई अधिक शब्द सीमा की प्रोत्साहन योजनाएं जारी रही एवं संस्थान के प्रवेश स्थल पर एक नवीन अंग्रेजी-हिन्दी शब्द एवं सुविचार लिखने की गतिविधि इस वर्ष भी जारी रही जोकि राजभाषा के प्रति रूचि जागृत करने का प्रयास था। यहां यह बताना भी प्रासंगिक होगा कि इस वर्ष हिंदी अनुभाग के अथक प्रयासों से संस्थान की वेबसाईट द्विभाषी की गई। संस्थान की वेबसाईट में 'हिंदी वर्ज़न' को क्लिक करने पर समग्र सामग्री हिन्दी में भी उपलब्ध है। इस प्रकार राजभाषा अधिनियम के अनुपालन की दिशा में एक और प्रयास किया गया। और तो और संस्थान के तकनीकी कर्मचारियों एवं अधिकारियों हेतु भी दिनांक 16 फरवरी 2017 को हिन्दी कार्यशाला का आयोजन किया गया जिसमें 'सरकारी कामकाज में राजभाषा हिंदी के प्रयोग' विषय पर व्याख्यान दिया गया। इसके अतिरिक्त कर्मचारियों को राजभाषा में कार्य करने एवं हिन्दी टंकण के लिए वॉइस टाईपिंग का विकल्प अपनाने की दृष्टि से माइक भी वितरित किए गए।

इसके साथ ही, सरकारी कामकाज में हिंदी के प्रगामी प्रयोग को बढ़ावा देने के उद्देश्य से प्रतिवर्ष की भाँति इस वर्ष भी हिंदी माह दिनांक 9-23 सितम्बर 2016 तक पूर्ण उत्साह के साथ मनाया गया जिसमें दिनांक 20 सितम्बर 2016 को प्रशासनिक वर्ग के अधिकारियों एवं कर्मचारियों के लिए कार्यशाला का आयोजन किया गया। इस कार्यशाला का उदघाटन डॉ. नीना वलेचा एवं संचालन श्री सी.एस. नम्बुदिरि, प्रशासन अधिकारी द्वारा किया गया। किन्तु, इसी के साथ निबंध प्रतियोगिता, टिप्पण-प्रारूपण प्रतियोगिता एवं कर्मचारियों और अधिकारियों के लिए पृथक-पृथक वाद-विवाद प्रतियोगिताओं का आयोजन किया गया।

हिन्दी माह के दौरान उल्लेखित गतिविधियों के अलावा दिनांक 23 सितम्बर 2016 को एक और गतिविधि, पुरस्कार वितरण समारोह एवं काव्य (हास्य) पाठ का आयोजन किया गया, जिसका संचालन डॉ. वंदना शर्मा, सहायक निदेशक (राजभाषा) द्वारा किया गया। संबंधित समारोह में मुख्य अतिथि के रूप में परिषद मुख्यालय से डॉ. राकेश कुमार (आईएएस), वरिष्ठ उपमहानिदेशक (प्रशासन) को आमंत्रित किया गया था और डॉ. आर.एन. तुली, एम.सी.डी., जिला स्वास्थ्य अधिकारी, दिल्ली को सम्मानित अतिथि के रूप में आमंत्रित किया गया था। इसके साथ ही संबंधित समारोह को रोचक बनाने के उद्देश्य से राष्ट्रीय स्तर के हास्य कवि श्री महेन्द्र शर्मा को आमंत्रित किया गया था।

समारोह का शुभारंभ मुख्य अतिथि, सम्मानित अतिथि, कवि एवं संस्थान की निदेशक महोदया को पुष्प भेंट कर किया गया। अतिथियों के स्वागत के पश्चात संस्थान के डॉ. बी.एन. नागपाल, वैज्ञानिक 'जी' द्वारा मुख्य अतिथि, सम्मा. नित अतिथि एवं कवि महोदय को शॉल भेंट कर सम्मानित किया गया और संस्थान की निदेशक महोदया द्वारा सभी अतिथियों को स्मृति चिह्न प्रदान किए गए। इसके पश्चात् निदेशक महोदया ने अपने संबोधन में सर्वप्रथम हिन्दी माह के दौरान होने वाली प्रतियोगिताओं के विजेताओं को बधाई दी और कहा कि आजादी के बाद से भारत सरकार द्वारा राजभाषा के प्रयोग को बढ़ावा देने हेतु प्रेरणा एवं प्रोत्साहन की जो नीति अपनाई जा रही है वह नीति काफी हद तक सफल रही है। हम भी धीरे-धीरे प्रगति की ओर बढ़ रहे हैं। माननीय गृहमंत्री जी के संदेश का संदर्भ देते हुए निदेशक महोदया ने इस अवसर पर अपना अधिक से अधिक कार्य पूरे उत्साह से राजभाषा हिन्दी में करने के लिए कहा। उन्होंने विश्वास जताया कि एक दिन हमारे संस्थान का समग्र कार्य राजभाषा में होगा। निदेशक महोदया के संबोधन के पश्चात् पुरस्कारों का वितरण किया गया।

तत्पश्चात् संस्थान द्वारा आमंत्रित सम्मानित अतिथि डॉ. आर.एन. तुली ने सभा को संबोधित करते हुए बताया कि मंत्रालय एवं सरकार द्वारा राजभाषा हिन्दी के प्रयोग को बढ़ावा देने हेतु हमें कई प्रकार से छूट भी दी गई है जिसके अंतर्गत

वाद-विवाद प्रतियोगिता में भाग लेते संस्थान के अधिकारी


निदेशक महोदया द्वारा सम्बोधन

वाद-विवाद प्रतियोगिता में भाग लेते संस्थान के कर्मचारी


मुख्य अतिथि डॉ. राकेश कुमार (आईएएस) समारोह को सम्बोधित करते हुए

यदि हम हिन्दी में कार्य की शुरूआत कर रहे हैं तो हमें अंग्रेजी शब्द को देवनागरी में लिखने की और बोलचाल की भाषा के प्रयोग की छूट दी गई है। इसलिए हमारा भी यह दायित्व है कि हमें अपने सरकारी कामकाज में राजभाषा के प्रयोग को बढ़ाना चाहिए।

इसके पश्चात् कार्यक्रम के अंत में मुख्य अतिथि डॉ. राकेश कुमार ने सभा को संबोधित करते हुए बताया कि हमें अपनी राष्ट्रीय अस्मिता को बचाना होगा। चाहे हम प्रगति के शिखर पर ही क्यों न पहुंचे किन्तु हमें अपनी जड़ों से जुड़े रहना होगा। उनके प्रोत्साहनमय संबोधन ने सभी को राजभाषा में कार्य करने की प्रेरणा दी, अपने कर्तव्य के प्रति सचेत किया तथा संस्थान में राजभाषा के प्रयोग की प्रगति की सराहना करते हुए निदेशक डॉ. नीना वलेचा के कुशल नेतृत्व की सराहना की। संबंधित पुरस्कार वितरण के पश्चात आमंत्रित हास्य कवि श्री महेन्द्र शर्मा ने विभिन्न समसामयिक विषयों पर अपनी हास्य एवं व्यंग्यपूर्ण कविताओं से आनन्द विभोर कर दिया। अन्ततः कार्यक्रम का विधिवत समापन संस्थान के डॉ. रमेश चन्द्र धीमान, वैज्ञानिक 'जी' द्वारा किया गया।

यहां यह भी बताना उल्लेखनीय होगा कि संस्थान ही नहीं वरन् संस्थान की क्षेत्रीय ईकाइयों में भी राजभाषा कार्यान्वयन के प्रति जागृत करने के उद्देश्य से हिन्दी दिवस के उपलक्ष में विभिन्न प्रतियोगिताओं का आयोजन किया गया, जिसमें नडियाड, बंगलुरू, जबलपुर एवं गोवा मुख्य हैं। इस प्रकार यह कहने में कोई अतिशयोक्ति नहीं होगी कि वर्ष 2016-17 के दौरान संस्थान एवं क्षेत्रीय ईकाइयों में राजभाषा के प्रयोग को बढ़ावा देने हेतु सृजनात्मक, रचनात्मक एवं व्यावहारिक कार्य एवं कार्यक्रमों के माध्यम से हर संभव प्रयास किया गया। संस्थान एक विज्ञानीय अनुसंधान संस्थान होने के साथ ही राजभाषा नियम अधिनियमों का अनुपालन करते हुए राजभाषा के प्रयोग को बढ़ावा देने में प्रयासरत है और इसका साक्षात प्रमाण राजभाषा संबंधी गतिविधियों का उल्लेखित सारांश है जो इसके बहुमुखी विकास का प्रतिरूप है। ❑

Committees of the Institute

12

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12.6 Animal Ethics Committee

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12.7 Publication Advisory Committee for JVBD

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Dr SK Ghosh
Dr Ashwani Kumar
Dr BN Nagpal
Dr Nutan Nanda
Dr K Raghavendra
Dr OP Singh

Scientists 'F'

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Mrs Rekha Saxena
Dr Arun Sharma

Scientists 'E'

Dr PK Atul
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Dr MK Das
Dr Neelima Mishra
Dr Abhinav Sinha

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Dr Alex Eapen
Dr Vineeta Singh

Scientists 'C'

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Dr Ram Das
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