ACTIVITIES AND ACHIEVEMENTS

1975 – 2020

INDIAN COUNCIL OF MEDICAL RESEARCH

VECTOR CONTROL RESEARCH CENTRE

Preface

Greetings!

Vector Control Research Centre (VCRC) was established at Pondicherry (now: Puducherry) by the Indian Council of Medical Research in July 1975. It initially started functioning from a rented building in the heart of the Pondicherry town.

Dr. N. Veeraraghvan was the founder Director of the institute entrusted with its establishment by the then Director General of ICMR, Dr. C. Gopalan. It was Padmashri Dr. P. K. Rajagopalan, during who's tenure, from 1977-1990, that the VCRC was built-up structurally and organizationally. An able administrator and a passionate scientist by nature, Dr. Rajagopalan was leading a team of dedicated and brilliant scientists and Technical Officers, who worked relentlessly in the laboratories and field, and with their significant scientific contributions, brought several laurels to the VCRC and the ICMR. Noteworthy contributions of those times were the tackling of malaria problem in Rameshwaram island, mosquito abetment project in Pondicherry, Bancroftian Filariasis Elimination Project in Pondicherry, Brugian Fliariasis Elimination project in Mission Mode in Cherthala, Kerala, and Tribal malaria control in Koraput, Odisha. Additionally, several other vector control projects were undertaken which are part of this document. From inception, VCRC has contributed immensely to the lymphatic filariasis control programme by providing research evidence for national guidelines and policy, for the control/elimination of LF, and the Centre received an international recognition

Dr. V. Dhanda (1990-96), Dr. P. K. Das (1997-2007), Dr. M. Kalayanasundram (2007-2008 as OIC) and Dr. P. Jamabulingam (2008-2019), the successive Directors, carried forward the mandate of the VCRC with a great enthusiasm and contributed immensely to the vector science at basic, applied and operational levels. WHO has recognised VCRC as collaborating centre for research and training in lymphatic filariasis and integrated vector management. In the recent times, VCRC has expanded its mandate to cover several vector borne diseases viz., malaria, filariasis, dengue, chikungunya, leishmaniasis, Japanese Encephalitis, scrub typhus and Kyasanur Forest Disease (KFD). Also, the Centre has embarked upon modernization of its laboratory infrastructure. Supported by the Department of NTD, WHO and ICMR, VCRC today boasts of state of the art GLP laboratories for testing modern vector control tools. VCRC is perhaps the only institution in the country and Asia, offering highly specialized Master's Degree course in Public Health Entomology with an aim to build entomological capacity in the country. Several students and professionals from within India and abroad have visited the Centre for research collaborations and training.

Commercialization of *Bacillus thuringiensis israelensis* (B-17) bio-pesticide technology to 20 national companies is a testimony to the high quality research conducted at the Centre. Several patents have been obtained and vector control tools, especially bio-control agents and their bi-products, have been developed over the years. Several other new products are in the pipeline and at various stages of development and shall be commercialised in due course. The Year 2020 has been declared as a year of innovation and product development. During 2019-2020 alone, Scientists of the institute have filed 10 patent applications and these innovations have good potential for commercialization.

As for catering to the national programme needs, VCRC has its presence in Kottayam in Kerala, Koraput in Odisha and Madurai in Tamil Nadu, where these field stations are carrying out applied and operational research on vector borne diseases *inter-alia,* vector and disease surveillance, molecular characterization of pathogens, phase II and III field evaluation of vector control tools, resistance management studies, situational analysis, demonstration of vector control, outbreak and epidemic investigations and rendering support to the respective state Govt. in their hour of need. VCRC runs a free filariasis clinic and provides services to lymphedema patients under specialised medical care.

We are grateful to Padmashri Prof. Balram Bhargava, Secretary DHR and DG, ICMR for his charismatic and visionary leadership and for evincing keen interest in the overall progress of VCRC and *Wolbachia* based dengue control technology being developed at the VCRC. We thank Prof. Bhargava for his encouragement and support to establish Centre of Excellence for Training in Medical Entomology (CETME). At this juncture, we would also like to thank the pillars of ICMR *viz.,* Division of ECD, Division of Translational Research, International Health Division, Administration and Finance for their unstinted and timely support in the smooth functioning of the Centre. VCRC is also indebted to the former Directors General and ICMR officials for their support. I am thankful to Dr. S. Sabesan and Dr. A. M. Manonmani for compiling and Dr. P. Jambulingam for editing this document on Activities and Achievements of ICMR-VCRC from 1975-2020, which I am happy and proud to present to you. Jai Hind!

Dr. Ashwani Kumar
Director

CENTRE'S PROFILE

ICMR-Vector Control Research Centre (VCRC), established at Pondicherry (now Puducherry) in July 1975, is one of the permanent institutes of the Indian Council of Medical Research, Department of Health Research, Government of India. VCRC has been engaged in basic and applied research with the primary objective of finding newer methods and developing strategies of vector control for the control of vector borne diseases. The World Health Organization (WHO) has designated the VCRC as a collaborating Centre for Research and Training in Lymphatic filariasis and Integrated Vector Management. The Ministry of Health and Family Welfare, Government of India in 2000 recognized the Centre as one of the Institutes of Excellence in India for Courses in Health Training.

Vision statement

- Vector-borne disease free India

Mission Statements

- Develop strategies for prevention and control/elimination of vector borne diseases.
- Develop epidemiological surveillance tools for vector borne diseases.
- Undertake human resource development activities to meet local/state/national/regional challenges.

Objectives

- Develop newer tools and innovative vector control strategies for vector borne disease control/elimination.
- Study the epidemiology of vector borne diseases in different ecological settings for optimization of intervention strategies.
- Carryout need based Human Resource Development.
- Provide technical expertise and assistance for effective prevention or control/elimination of vector borne diseases and vectors/other arthropod nuisance.

Key performance areas

- Vector biology, ecology and integrated vector management.
- Diversity of vectors and parasites.
- Insecticide resistance monitoring and management.
- Development of tools for diagnosis and decision support.
- Optimization of intervention strategies.
- Manpower development.

FACILITIES

Cyclic colony of mosquitoes

Cyclic colonies of four species of mosquitoes (*Culex quinquefasciatus, Anopheles stephensi, Aedes aegypti* and *Toxorhynchitis splendens*), and one species of house fly (*Musca domestica*) are maintained in the Institution to meet the demands for conducting laboratory experiments.

Mosquito Museum

A repository of 33,700 specimens belonging to 268 species collected from different parts/ecosystems of India.

27 species are new country records and 6 are new species.

For 170 species of mosquitoes, associated larval and pupal exuviae preserved.

Animal House

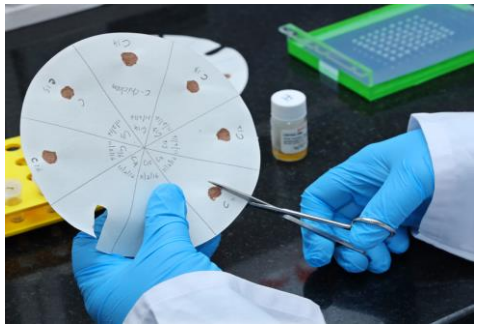
VCRC has a CPCSEA approved animal house facility, in which Balb/c mice, multimammate rats and mongolian gerbils are maintained.

Brugia malayi filarial parasite colony is being maintained in multimammate rats and mongolian gerbils. Newly formulated antifilarial drugs are screened for their efficacy in these animal models.

Vector blood meal identification

The source of blood meal (from human, bovine, chicken and canine) of fed vectors is identified using immuno-diffusion technique.

This facility is also made available to other institutes.



DNA sequencing

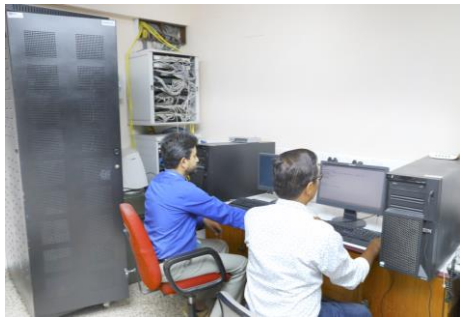
16 capillary AB 3130X1 Genetic Analyzer.

Insecticide Impregnated Papers

VCRC has standardized preparation of Insecticide Impregnated Papers (IIPs) for testing susceptibility/resistance in vector mosquitoes. Awaiting validation.

Electronic Data Base System

NIC backed website services - National knowledge network (NKN) with 100 mbps high bandwidth internet services - 100 nodes of LAN points - 4 Cisco switches for core networking facilities - Hardware based firewall for the protection of institutes' systems - Data server facilities for centralized data storage options - CCTV systems for surveillance - Phase based E-office implementation - Centralized Aadhaar based attendance system.



Library

Library has collection of 8592 books; 4694 back volume journals and 18 International & 9 National journals on vector borne diseases. The Information Centre provides gateway access to four leading journals through ICMR consortium (Lancet, Nature, The New England Journal of Medicine, Science). Library access for ERMED Consortium (243 Journals) from 5 Publisher and J Gate Plus (1083 journals).

Library having a bibliographic data bank on Vector Borne Diseases and their Control (VBDC), which encompass 4.8 lakh records with abstracts. And a full text data bank on VBDC, which holding 44,578 papers.

Library is equipped with the state-of-art e-Granthalaya 3.0 automation software, which is an integrated multi-user library management system and providing Web OPAC (Online Public Access Catalogue) service to library users for getting information about library collections. The library having plagiarism detection service through "iThenticate" Plagiarism checker software for Scientists, Research Scholars and students.

Institutional Repository (IR) "Dspace@ICMR-VCRC Library" is a digital service that collects, store, preserves and distributes Institutional Publications (VCRC Publications, Thesis, Dissertations, Annual Report (42), and Newspaper Clipping etc.)

VCRC Publication as on March 2020: 1049 (International Journals - 594 and National Journals - 455). Library having Miscellaneous publications/Reports/Pamphlets (45).

ACHIEVEMENTS

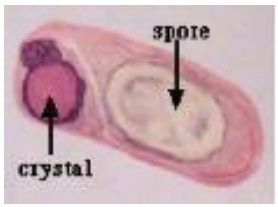
I . Development of new vector control agents/tools

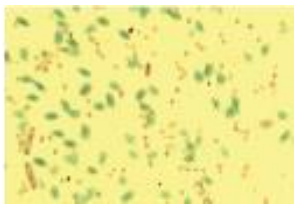
Several products have been developed for the control of mosquitoes, which are in various stages of development.

Biopesticides and bio-control agents

Bacillus thuringiensis var. *israelensis*

Bacillus thuringiensis var. *israelensis* (Bti) (VCRC B17), a naturally occurring bacterial pathogen of mosquito larvae was isolated from the paddy fields of Puducherry. The mass production technology of the bacterial toxin has been developed up to pilot scale and assigned to National Research Development Corporation (NRDC), New Delhi, for commercialization. Production technology related to the Aquoeus Suspension formulation has been licensed to 20 commercial firms. An Indian Patent has been granted # 192055.





VCRC also developed a technology to produce Bti toxin from a cheaper bird feather based fermentation medium for which another patent was granted (***Indian Patent No: 255023***).

B. thuringiensis tochigiensis var. *israelensis*

A mosquito larvicidal isolate, *Bacillus thuringiensis* was isolated from mangrove forest soil and was found to share the antigens of *tochigiensis* and *israelensis* (VCRC B474). This strain is effective against all mosquito vector species and its activity is comparable to that of Bti (VCRC B 17). Hence, this isolate is yet another prospective candidate that can be developed further for use as a mosquito larvicide.

Flyash based mosquitocidal biopesticides

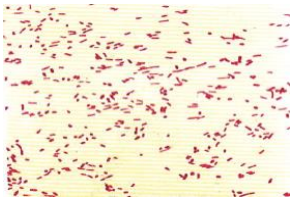
In a collaborative project with Neyveli Lignite Corporation, Neyveli, different types of formulations, namely Water Dispersible Powders, Floating Briquettes and Submerged Granules were developed using *Bacillus thuringiensis* var. *israelensis* (VCRC B17) isolate and coal ash as carrier material. These formulations exhibited safety to associated aquatic non-target organisms, agriculturally important insects as well as to mammals. All the formulations were found to be effective against the larval stages of different species of mosquitoes and exhibited varied levels of residual activity depending on the habitat, type of water etc. Process patents filed in India, Bhutan, Nepal and Myanmar.

Bacillus subtilis

Cyclic lipopeptides of *Bacillus subtilis* subsp. *subtilis* (VCRC B471), an indigenously isolated bacteria from mangrove forest soil was found to be effective against all life stages of mosquitoes. This is the first report of a mosquito pupicidal gram positive bacterium. Safety tests have shown that the metabolites are safe to non-target aquatic organisms and mammalian systems. Simulated field trials have shown that the metabolite was effective against *Anopheles stephensi* (malaria vector) & *Aedes aegypti* (dengue vector). Three round of phase II trials conducted against *Anopheles stephensi* breeding in construction sites at Goa yielded above 80% reduction for up to 15 days. An Indian Patent has been granted. An Indian Patent has been granted # 264599.

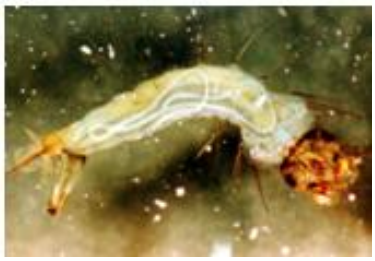
Pseudomonas fluorescens

The secondary metabolites of a gram negative bacterium, *Pseudomonas fluorescens* (VCRC B426) was found to be effective on the pupal stages of mosquitoes. This is the first report of a mosquito pupicidal gram negative bacterium. Safety tests have shown that the metabolites are safe to non-target aquatic organisms and mammalian systems. Preliminary testing of this bacterial metabolite in field conditions caused significant mortality of *Culex quinquefasciatus* pupae and suppression of adult emergence. It maintained >80% reduction in the pupal density for 10 days. Three rounds of phase II trials conducted against *Anopheles stephensi* breading in



construction sites at Goa yielded above 80% reduction for up to 12 days. An Indian Patent has been granted #192872.

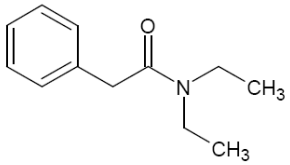
Romanomermis iyengari



An indigenous nematode species, *Romanomermis iyengari* was isolated from paddy field larval populations at Puducherry. It was amenable to mass cultivation and was capable of parasitizing a wide range of mosquito larval hosts. It was found to be successful in controlling mosquitoes breeding in rice field, grass land and tree-hole habitats and was found to persist in the treated sites even after 20 years of application. This agent could be a potential one to regulate the mosquito population.

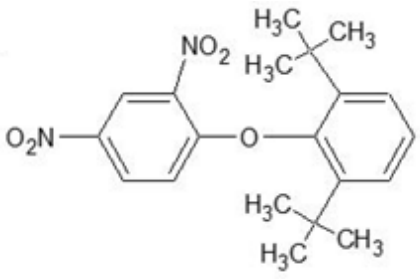
DEPA

Developed a synthetic mosquito repellent DEPA (N, N-DIETHYL PHENYL ACETAMIDE) - formulated as vanishing cream, a polymer based liquid and a microsphere lotion in the laboratory. The technology was transferred to Defense Research and Development Establishment, Gwalior for commercial exploitation.



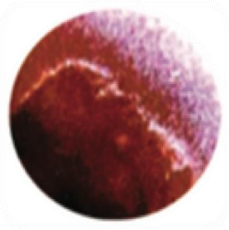
DPE - 28

Developed an insect growth regulator DPE-28 which shows juvenile hormone activity against mosquito larvae and its controlled release formulation. An Indian Patent (No. 191820/2005) was obtained. Acute toxicity studies showed that DPE-28 is safe to mammals. Further studies are underway to develop formulations and to find the dosage for field application.

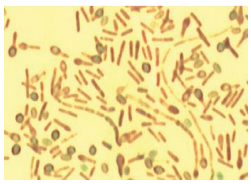


By-products of bio-pesticides

Thrombinase

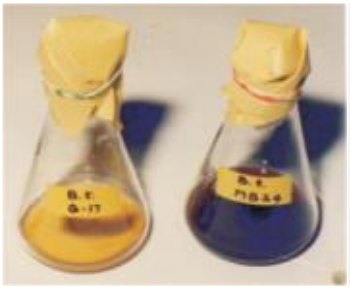


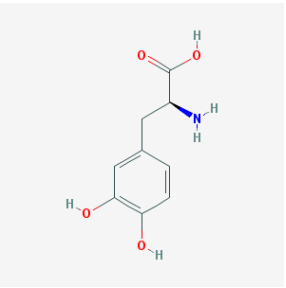
Thrombinase, is a fibrinolytic enzyme obtained as a by-product from the spent medium of a mosquito larvicidal agent, *Bacillus sphaericus* (VCRC B42). This enzyme has potential for use in the treatment of cerebral Thrombosis, myocardial infarction, deep vein thrombosis and prevention of post-surgical adhesion. This product is not a plasminogen activator, but it acts specifically on fibrin clots. Toxicological data have been generated through animal experimentation. The product has been cleared by Drug Controller General of India (DCGI) for Phase I clinical trials. The technology has been transferred to M/s Maladi Research Centre, Chennai, through NRDC, New Delhi. US patent #5434059 and European patent #0624642, Indian patent #196869 granted.



L-DOPA

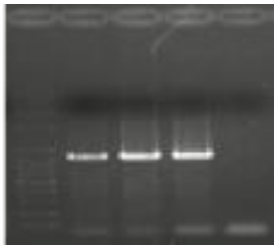
A mutant strain (VCRC MB24) developed from *Bacillus thuringiensis* var. *israelensis* (VCRC B17) isolate was found to produce L-DOPA (3,4-dihydroxyphenyl-L-alanine). L-DOPA is an important therapeutic agent used in many neurodegenerative diseases, especially for the treatment of Parkinson's disease, a condition caused by a deficiency in the formation of dopamine by the dopaminergic neurons of the brain. Efforts are going on to improve the process of optimal level of production of this compound.





Bacillus amyloliquefaciens

Secondary metabolites from a bacteria, *Bacillus amyloliquefaciens* (VCRC B483) isolated from mangrove forest soil was found to exhibit mosquitocidal, anti-microbial and keratinase activity. The metabolites have been found to be effective against multi drug resistant clinical bacteria. Production technology – both upstream & downstream processes have been optimized.



Cyclosporine

An immunosuppressive drug, Cyclosporine was obtained from a mosquitocidal fungus, *Tolypocladium* sp. (VCRC F21). Cyclosporin A is a cyclic undecapeptide with anti inflammatory, immunosuppressive, antifungal and anti-parasitic properties. Its immunosuppressant property has revolutionized organ transplantation worldwide. A laboratory scale process for the production of cyclosporine A and a HPLC method for the identification of cyclosporine A, B and C isomers were developed. An Indian Patent #182916; European Patent # EP-725-076-EP-300674, Canadian patent # 2,142,240 and US Patent # 5,656,459 have been granted on this technology. The technology has been transferred to M/s Nixcil Pharmaceuticals & Specialities, Lucknow, through NRDC, New Delhi. Recently, the technology was further improved by the ICMR – VCRC to reduce the cost. Patent filed under Patent Cooperation Treaty (PCT).

Dehairing enzyme

A proteolytic enzyme, capable of de-hairing animal skin was obtained as a by-product from the spent medium of the mosquito larvicide, *Bacillus thuringiensis* var. *israelensis* (VCRC B17). This dehairing enzyme has potential to find high utility in tannery industries.

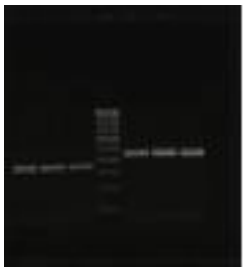
II. Diagnostics

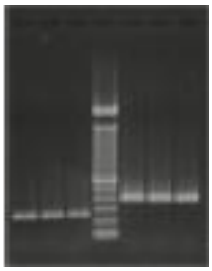
The Centre has succeded in developing newer tools for identification of major vectors and enhancing the methods involved in diagnostic technology.

Molecular diagnostics for insect vectors

An. fluviatilis and *An. culicifacies*

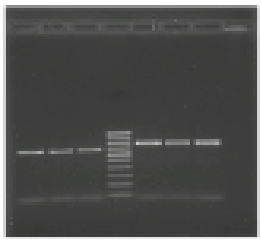
Major malaria vectors, *Anopheles fluviatilis* and *An. culicifacies* are members of species complexes. As the members within the species are morphologically alike, rDNA-ITS2 region based probes were developed for their identification. This DNA based tool can be employed on any tissue/stage/sex of mosquito, as well as for identifying the vector species from pools of non-vector/other species.





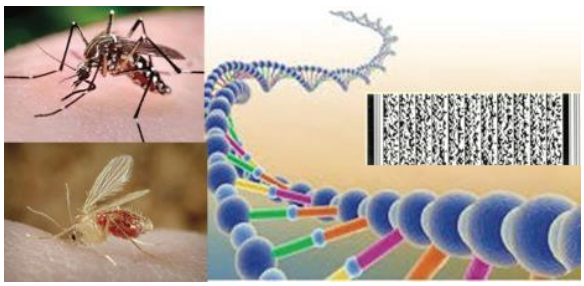
Sandflies

The conventional method for identification of *Phlebotomus* sp. is based on morphological and anatomical features, requiring dissection and mounting of the head and abdomen of freshly collected sand fly specimens or specimens preserved in 70% alcohol for viewing spermathecae, male genitalia, cibarium and pharyngeal armature. An 18S-rDNA region based PCR assay was developed for differentiating *Phelobotomus argentipes* & *Ph. papatasi* that can be used on any available insect material, i.e., fresh, dead, dried material, or even with any insect tissue.

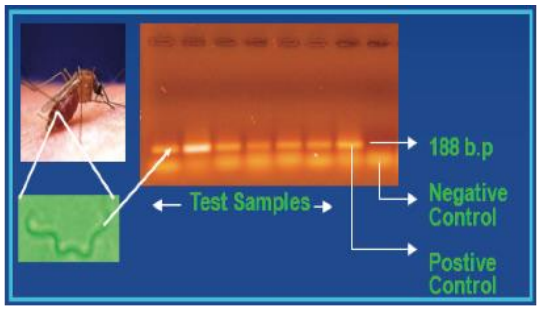

DNA Barcodes for Mosquitoes

DNA Barcodes were developed for all the common species of mosquitoes prevalent in India (152 species). 2D Symbology was proposed for DNA Barcoding and is exhibited in the VCRC Mosquito Museum for each species. VCRC is a member of the Global consortium for the Barcodes of Life (CBOL). DNA Barcodes could be used for accurate identification of the species from DNA extracted from a very small piece of tissue.



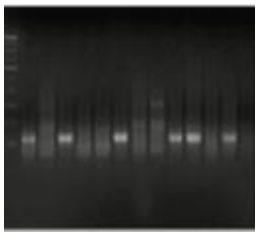
New DNA extraction method

A simple (TE buffer based), rapid and cost effective DNA extraction method has been developed for molecular xenomonitoring of *W. bancrofti* in pools of vector mosquitoes in a high throughput format, as a surveillance tool for assessing post MDA situation in PELF.



RT-PCR assay for detection of infective (L3) stage larvae of *Wuchereria bancrofti*

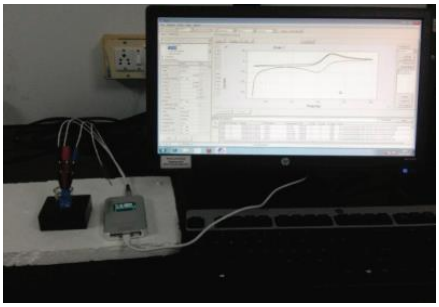
A stage specific RT-PCR assay was developed for the detection of infective (L3) stage larvae of *Wuchereria bancrofti* in vector mosquito *Culex quinquefasciatus*. Multi-centric evaluation carried out in four participating centres indicated that the assay was as sensitive and stage specific as the conventional mosquito dissection technique. Since the L3-detection assay provides a more direct measure of transmission risk, this will be useful as a sensitive method for monitoring ELF programmes. This assay could also be a non-invasive surveillance tool for early detection of LF resurgence during post MDA. The assay has been established in several Centres across the country and man power for performing the assay has been developed.



Electrochemical based biosensor for detection of *Wuchereria bancrofti*, in vectors

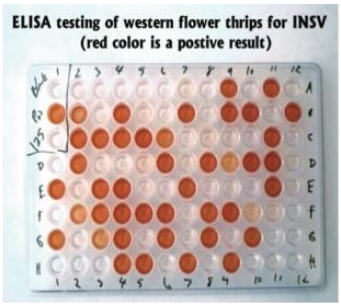
Designed a miniaturized portable electrochemical based biosensor for detection of lymphatic filarial parasite, *Wuchereria bancrofti*, in vectors. The prototype product comprises an assembly of DNA probe sensitized screen printed electrode, a miniaturized potentiometer and signal detector (laptop/tablet computer). Process

and product patents have been filed. Efforts are underway to improve the prototype further, and to detect the filarial antigen in human blood samples.



Immuno-diagnostic tool for antigen assay

A more sensitive Immuno-diagnostic tool utilizing filarial specific monoclonal antibodies has been developed at the centre. Sensitivity and specificity of the detection of *W. bancrofti* Circulating Filarial Antigen (CFA) by Immuno Chromotographic Test (ICT) was evaluated in comparison to the conventional technique in South India. ICT was shown to be technically feasible for field surveys to detect LF endemic areas and evaluation of intervention programmes. This is now being used in the evaluation of LF elimination programme.



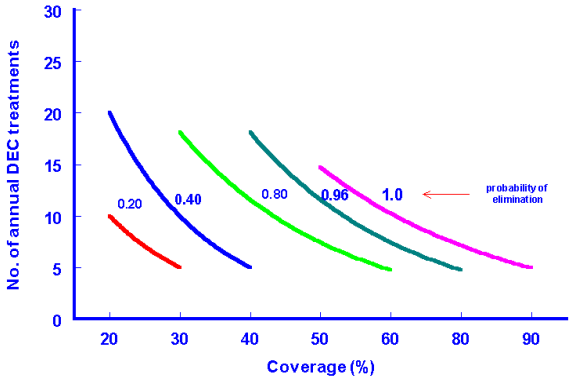
III. TOOLS FOR DECISION SUPPORT

Two mathematical models have been developed in collaboration with Erasmus University, The Netherland and Oxford University, UK. The models are used as decision support tools in the ongoing LF elimination programme of our country and else where not only for monitoring and evaluation; but, also for predicting the trends / outcome of mass drug administration (MDA) in relation to its efficacy and effectiveness.

Mathematical models

The data generated from the VCRC project on the control of filariasis in Pondicherry was used to develop deterministic (EPIFIL) and stochastic simulation models to predict the outcome of the LF control programmes. Using the stochastic simulation model, the impact of the MDA was predicted in order to guide the program managers to decide on the number of rounds of MDA required for a given level of drug consumption. For instance, the actual treatment coverage

of 65 % under operational settings, the model predicts that 10 rounds of DEC are necessary to achieve LF elimination. The outcome of this prediction was considered while reviewing the progress of PELF and the methods for improving the coverage have been identified.



Prospects of elimination with 3-drug regimen over 2-drug regimen

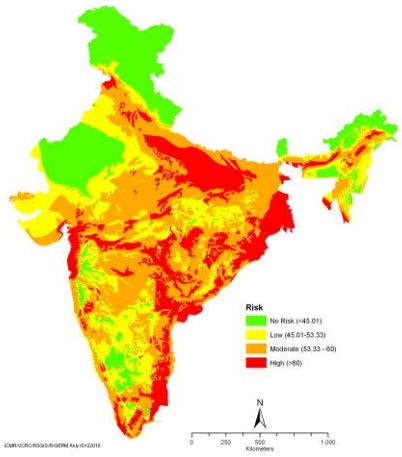
The LYMFASIM simulation model was applied to assess the prospects of elimination with IDA (ivermectin, DEC and albendazole) in districts where the programmes failed to achieve elimination after > 10 annual rounds of MDA with DA. The model predictions showed that MDA-IDA with 65% coverage can achieve elimination in 2-3 rounds compared to 5 annual rounds of MDA with DA. The outcome facilitated the WHO to recommend IDA as an alternative strategy for LF elimination and Ministry of Health & Family Welfare, Government of India approved its use to accelerate LF elimination in the country.

Optimizing evaluation unit (EU) size for transmission assessment survey (TAS)

Currently, TAS is the WHO recommended protocol for making programmatic decision on stopping MDA in an evaluation unit (if district population $\leq$ 2 million). Modelling studies at VCRC, simulating TAS results at district level showed that despite passing TAS after 7 MDAs, the district could have sub-districts with risk of continuing transmission (hotspots) in 19-39% villages/wards. Further, cost-benefit analysis showed that downsizing EU from a district to sub-district level could reduce the programme cost from 1.5 lakh USD to 0.5 lakh USD per district. In this context, downsizing is recommended as one of the strategies for the enhanced post MDA surveillance for monitoring and evaluation of accelerated LF elimination.

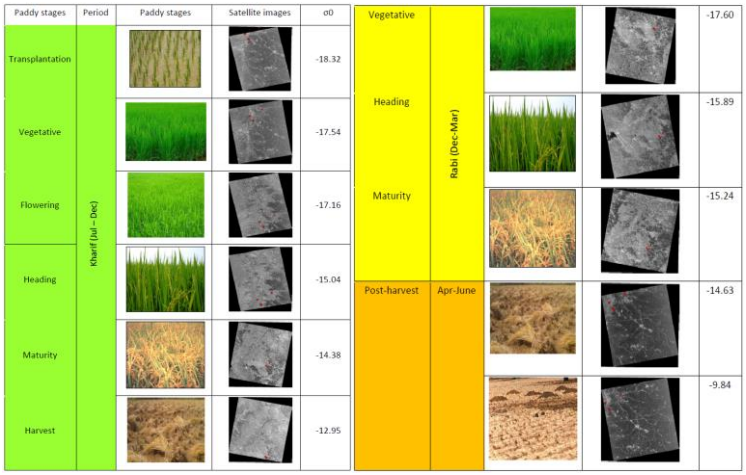
Geographical Information System (GIS) based Model

A filariasis transmission risk map has been created for India, using geo-environmental risk model (GERM) developed on GIS platform at VCRC. Among the 190 districts hitherto unsurveyed, as many as 113 districts were predicted to be at risk, and the remaining at no risk. The risk map is useful to identify areas at risk for undertaking surveillance and intervention, if needed.



Application of space technology for forecasting Japanese encephalitis (JE) vector abundance

A model was developed based on the data from Bellary, Karnataka which showed a relationship between satellite borne remote sensing data with different stages of paddy growth and JE vector abundance. Subsequently, it was validated with data from Gorakhpur, U.P. Based on this technique, development of a JE vector map has been initiated for the country to depict the risk in terms of space and time in all the paddy growing JE endemic areas.



Xenomonitoring, an alternative for human sampling in TAS

A two stage cluster design based vector surveillance strategy (sampling design, gravid-trap, PCR assay) for post-MDA vector surveillance ('xenomonitoring') was developed and validated in one of the evaluation units (EU) in Cuddalore district, Tamil Nadu. Further validation of the strategy is in progress in 3 districts (TAS failed, TAS passed once, and twice). The strategy is being recommended to support its adoption as a standardized protocol for global LF elimination programs (*WHO/HTM/NTD/PCT/2013.10; NVBDCP National Programme Guidelines, 2016-Draft*).

IV. SITE-SPECIFIC STRATEGIES FOR THE CONTROL OF VECTOR-BORNE DISEASES

The problems of vector(s) and vector borne diseases are always 'local – focal', and hence developed varied site-specific strategies depending on the unique situations prevailing there.

Malaria in Thenpennaiyar riverine tract of Tamil Nadu (1977 – 1983)

Outdoor resting behaviour of *An. culicifacies* was one of the causes for continued transmission. Species A was relatively more anthropophilic than species B. Peri-domestic ground applications of ULV cold aerosol using technical malathion and antilarval measures were recommended to control malaria.

Malaria in Salem urban area (1976 – 1979)

Anopheles stephensi was found to transmit urban malaria in Salem, Tamil Nadu. Weekly anti-larval measures and ultra low volume fogging with appropriate insecticides were recommended during the peak transmission period.

Malaria in Rameswaram island, Tamil Nadu (1981 – 1985)

The island had been highly endemic for malaria caused by *Plasmodium vivax* and *P. falciparum*. Entomological studies confirmed that *An. culicifacies* was the only vector involved in transmission. Large scale fishermen movements were identified to be responsible in creating foci of transmission and spreading of infection. A map of the fisher movement was created. The need for adequate coverage of these moving population by surveillance and treatment, and vector control with insecticidal spraying was recommended.

Malaria in tribal tract of Orissa (1986 – 1991)

Koraput district of Orissa is one of the hard core malarious areas in India, with multiple vectors (*An. fluviatilis* – a major vector sp breeding predominantly in

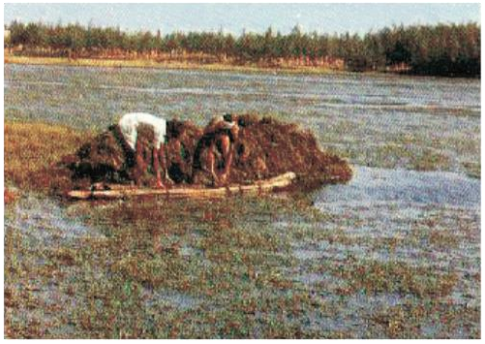
streams). *Plasmodium falciparum* was the predominant species (86%), *P. vivax* constituted about 10-14% and *P. malariae* (3-5%). Mixed infections were common. For the first time *P. ovale* infection was detected here. Integrated vector management (IVM) strategy with controlled release of streamwater through bed-dams and sluice gates, long lasting insecticide nets, rational use of appropriate indoor residual spray has been advocated to control malaria.

V. DEMONSTRATION PROJECTS

Newer vector control technologies and strategies were demonstrated in selected high endemic sites on time bound and target oriented project mode(s), mostly on the request of respective State Health Department in collaboration with the stakeholders.

Malaria control in coastal ecosystem [1980 – 1985]

Anopheles subpictus was incriminated as a natural vector of malaria for the first time in the country. *Gambusia affinis*, a larvivorous fish was used to control the breeding in casuarina pits. Presence of *Enteromorpha compressa*, a floating alga was found to shield immatures of vector mosquitoes from predatory fishes. Local community was motivated to collect and supply the algae to the paper industry and vector control achieved as a by product. No indigenous malaria cases were recorded since 1983 following this intervention.



Control of Bancroftian filariasis through IVM strategy in urban areas of Pondicherry [1981 – 1986]

The project was launched with an aim to reduce the transmission of filariasis by lowering the vector density to the minimum level possible by Integrated Vector

Management (IVM). The IVM strategy comprised of source reduction, waste water management, long term planning of waste water disposal systems, judicious use of insecticides and larvivorous fishes and Information, Education and Communication campaign. The active participation of various Government Sectors of Puducherry and community was mobilized. The project achieved drastic reduction of the vector population which was maintained at a very low level throughout the project period. Children born during the project period were free from filarial infection.

Malaria control in a tribal area involving the Traditional Health Healers [1995 – 2000]

A drug delivery system was developed for malaria control by involving the traditional health healers (Disharis) in treating fever cases (presumably malaria cases) in remote tribal villages of Odisha. Since majority of disharis have no formal education, they were trained to provide treatment with the help of a pictorial guide and pre-packed tablets. Consequently, the number of fever days has been reduced from 5-15 days to 2-3 days.

Technology Mission Project for the Control of Brugian Filariasis in Cherthala (previously: Shertallai), Kerala [1986 – 1997]

A unique People's Movement for Filariasis Control (FILCO) in Cherthala (previously: Shertallai) evolved into a self reliant body with multifaceted activities towards vector control, parasite control and dissemination of filariasis control messages through Public Information Campaigns. Control strategies adopted include, integrated vector management through weeding of ponds, composite fish culture and source reduction. Health care delivery by detecting and treating

microfilaria positive cases, and mass drug administration to all subjects in the high risk of infection areas was advocated to reduce parasite load in the community. This has resulted in the successful interruption in transmission of *B. malayi* in the operational areas, with no new infection in the age class 1-7 years and a drastic reduction of the parasite load (80.3%) in the community.

Composite fish culture of fast growing and weed eating edible fishes in the domestic ponds was introduced. And, subsequently the cultivation of leguminous plants ('sunhemp') was promoted as source of green manure to dispense with the practice of maintaining aquatic weeds in the ponds. Thus mosquito control became a by-product of the daily activities of the people.

The National Bank for Agriculture and Rural Development (NABARD) has sponsored this concept of 'Agriculture' for 'Health' by providing financial assistance to all those who adopted this strategy through its 12 Subsidiary Bank Branches.

Development and demonstration of Integrated Vector management strategy for the control of dengue/chikungunya vectors in rubber plantations of Kerala [2008 – 2013]

The project was carried out in collaboration with the Rubber Research Institute of India (RRII) and Department of Health Services, Govt. of Kerala in the wake of the large scale outbreak of Chikungunya in Kerala state during 2007, where the sero - prevalence of CHIKV infection in the community was estimated to be about 68%. *Aedes albopictus*, the predominant mosquito species was incriminated as the vector involved in the CHIKV outbreak in rubber plantations.

An Integrated Vector Management (IVM) strategy was successfully demonstrated, with all the stakeholders (including rubber producers' society, plantation workers, community and student volunteers) in the project areas [Chethackal in Kottayam district and Aimcompu in Pathanamthitta district]. The vector breeding [both Container Index (CI) and Pupal Index (PI)] reduced drastically and was maintained very low through entire study period and there was no incidence of dengue/chikungunya in the study area.

School based vector control and surveillance for prevention of dengue in Puducherry [2013 – 2016]

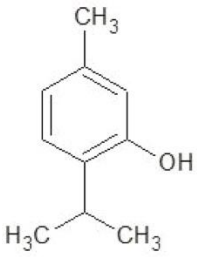
A school based strategy was demonstrated in four dengue prone villages in Puducherry for constant community motivation and vector surveillance. Seventh and 8th grade students trained in vector surveillance using pictorial format and source reduction, conducted entomological surveys in the village by house to house visits and demonstrated how to keep the premises free from vector breeding. Breeding indices were below the risk level and there was no case of dengue during the intervention period. Fortnightly survey data is electronically transmitted to State NVBDCP for action. This model is proposed to be extended to cover all the schools in Puducherry.

VI. LEAD MOLECULES FOR ANTI-FILARIAL DRUG

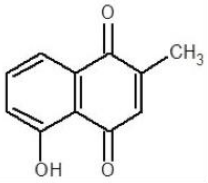
As LF elimination being a priority of the Centre, indigenous medicinal plants with known anthelminthic property were screened for macrofilaricidal activity, and isolated lead molecules of potential anti-filarial drug(s).

Parasite control agents

A macrofilaricidal lead molecule, a monoterpene with phenolic properties was isolated from *Trachyspermum ammi*, an indigenous medicinal plant. In vivo macrofilaricidal activity was confirmed at CDRI, Lucknow. An Indian Patent (*No.274393/2016*) was obtained. Further, two monoterpene combinations having *in vitro* macrofilaricidal activity have been identified for which *in vivo* studies are underway.



A macrofilaricidal lead molecule 5-hydroxy-2-methyl-1, 4-naphthoquinone from *Plumbago rosea/indica* was isolated from an indigenous medicinal plant. An Indian Patent (No. 280638/2017) was obtained.



Further, analogues of the lead molecule were synthesised and tested for *in vitro* macrofilaricidal activity. Six macrofilaricidal molecules with favourable absorption, distribution, metabolism and elimination (ADME) properties were identified, for which in vivo studies are underway.

VII. Drug trials against lymphatic filariasis

- Hospital based and village scale studies on the safety, efficacy and effectiveness of DEC and Ivermectin alone and in combination against lymphatic filariasis showed both are safe and the impact on transmission and prevalence of infection was comparable (1993–2003).

- An effective interruption in transmission of *B. malayi* via mass drug administration (MDA) with annual single dose DEC (6 mg/kg body wt.) was demonstrated at the community level in Cherthala, Kerala (1987–1989) for the first time and the same strategy showed success for *W. bancrofti* in Puducherry (1988–1990), too.

- Large scale field study on the effectiveness of co-administration of DEC and Albendazole in comparison with DEC alone as Mass Drug administration towards filariasis elimination showed that co-administration has an edge over DEC alone in reducing infection prevalence and sustaining the impact even in the absence of intervention (2000–2006). This result was considered in making co-administration as a national drug policy.

- A Community based trial was undertaken in Yadgir, Karnataka to assess safety, acceptability and efficacy of adding a third drug, Ivermectin, to the existing regime of two drugs (2016–2017). Preliminary observations revealed it is safe and is likely to be considered for adopting globally and nationally in the MDA for ELF.

III. MASTER PLANS FOR MOSQUITO CONTROL

Many Municipal Corporations have witnessed a high mosquito menace, following the urban agglomeration and in response to their request, the Centre has prepared comprehensive Master Plans for mosquito control.

Municipal Corporation, Bangalore, Karnataka [1980 – 1987]

The plan included an overall area of about 500 sq.km with a population of about 4 million. The problem of mosquito menace in Bangalore City is mainly due to *Culex quinquefasciatus*. Periodical cleaning and desilting of storm water canals and drains and lining of kutcha drains were suggested as short-term measures to prevent mosquito breeding. Cesspools and low lying vacant plots are to be filled with debris and silt removed from the drains.

Township, Neyveli Lignite Corporation, Tamil Nadu [1985 – 1989]

Neyveli Lignite Corporation (NLC) is an industrial complex in Tamil Nadu where lignite mining and power production are undertaken. The major problem leading to the creation of mosquitogenic condition is continuous pumping of water into the plots which results in permanent water logged areas. Larvicidal application in cess pits and cess pools, stocking of unused and used wells with larvivorous fishes, mosquito proofing of outlets of septic tanks, management of domestic and peridomestic containers, hermetical sealing of overhead tanks and environmental management for low lying water filled vacant plots, were recommended to control mosquito breeding in NLC area.

Municipal Corporation, Kochi, Kerala [1990 – 1996]

The city is situated in the lowlands of Ernakulam district, its elevations not exceeding 25 feet above MSL. Many areas are perennially waterlogged and thereby prone to mosquitogenic conditions. The total surface area is about 95 sq.km with a population of 5.13 lakh. A year round study showed that *Culex quinquefasciatus* was the most abundant man biting mosquito. It constituted about 76% of the total mosquitoes belonging to 13 species recorded in this area. A modified strategy that could be manageable within the available infrastructure has been recommended. Appropriate methods suitable to different breeding habitats have been suggested.

Municipal Corporation, Vishakhapatnam, Andhra Pradesh [1999 – 2000]

At the request of the Commissioner of the Visakhapatnam Municipal Corporation for controlling the mosquito menace in the area, a situation analysis of the mosquito control activities was made which showed that improper maintenance of canals, drains and septic tanks are responsible for profuse breeding of mosquitoes. Training was imparted to the Corporation Engineers, Biologist and other auxiliary staff on various aspects for curtailing mosquito menace. An action plan for reducing mosquito control in VMC area has been prepared and handed over to the Commissioner, VMC.

IX. HUMAN RESOURCE DEVELOPMENT

One of the mandates of VCRC is Man Power Development in the field of Public Health Entomology especially on the control of vectors and vector-borne diseases to meet the needs at the National and International levels. VCRC has been recognized for conducting the following Post-Graduate studies by the Pondicherry University.

1. **M.Sc., Public Health Entomology:** A two year degree course in M.Sc. Medical Entomology (1986–1998) and a one-year Post Graduate Diploma course in Medical Entomology (PGDME: 1997-2011) have been conducted. So far a total of 83 candidates from M.Sc. Medical Entomology and 41 candidates from PGDME successfully completed the course.

   At present, the centre is conducting a two-year degree course in M.Sc. Public Health Entomology from the year 2011. So far, a total of 69 (July 2019) candidates, including 3 from abroad sponsored by WHO and one in-service candidate from State & National organizations have successfully taken this course.

2. **Ph.D. programme:** Doctoral degree programmes have been carried out in the disciplines of Zoology, Microbiology, Chemistry, Statistics and Epidemiology. A total of 61 candidates have obtained Ph.D., degree so far.

3. **Students' Projects:** Graduate/Post Graduate students from Indian Universities and students from abroad under Foreign Universities Linkage Programme are given short term projects.

Name of the College/University	*No. of candidates*
Indian Universities	58
Observational Lab /Field visits (Research/PG/UG Students)	5643
St. Olaf College, USA (since 2000)	34
Georgetown University, USA (since 2009)	19
Erasmus University, Netherland (since 2006)	10






4. **Informal Training Programme:** Students, Faculties / Researchers & Public Health Personnel from various Institutions are offered training for varying period in their areas of interest in vectors and vector borne diseases. The number of persons benefitted under different programmes are given below:

Continuous Medical Education	124 Medical Officers
Malaria Control	42 Health Officials
Filariasis Control	5 Medical Officers
Morbidity Management of filariasis	79 Health workers
Medical Entomology	3 Medical Officers
Malaria Entomology & Vector Control	3 Health Officers from DPR, Korea
Epidemiology & Control of VBDs	3332 Life Sci. & Medical Students

5. **Formal Training Programme:** Entomologists / Biologists and Public Health Personnel from India and abroad sponsored by National Vector

Borne Disease Control Programme (NVBDCP), Delhi and WHO / SEARO, Country Offices are given formal training, as under.

NVBDCP (since 2013) Integrated Vector Management (IVM)	42 Entomologists/Biologists
WHO -Comprehensive Vector Control (CVC)	99 Health Officials
Integrated Vector Management (IVM)	67 Health Officials

6. **Workshops:** In view of the implementation of intervention, monitoring and evaluation of various vector borne disease control programme towards accomplishing the National and Regional agenda, the Centre is organizing workshops in collaboration with the WHO / SEARO and NVBDCP, from time to time.

Regional Training of Trainers Workshop on Transmission Assessment Survey in Lymphatic Filariasis in the year 2015 (Jointly org. by VCRC & WHO-SEARO)	30 Health
Regional Capacity Building Workshop on Transmission Assessment Survey in Lymphatic Filariasis Elimination in SEA Region in the year 2015 (Jointly org. by VCRC & WHO-SEARO)	35 Health
National workshop on "Entomological Capacity Building/strengthening" sponsored by ICMR-VCRC, Society for Vector Ecology (SOVE), Indian region and Co-sponsored by National Vector Borne Disease Control Programme (NVBDCP) and National Academy of Vector-Borne Diseases (NAVBD) 2020	26 Entomologist/Biologist

Students' Hostel

Separate hostel facilities for men and women students are available with all basic amenities.

Campus

Healthy and encouraging campus life ensured with facilities for indoor games and cultural activities.

Canteen is available inside the campus for staff and students.

X. COLLABORATION & NETWORKING

The Centre is engaged in establishing and strengthening local / state / national / international linkages and networking of all partners on equal footing.

Local:

- State Public Health Departments, Educational Institutes & Other Research Institutes

National:

- National Vector Borne Disease Control Programme (NVBDCP), New Delhi
- National Research Development Corporation (NRDC), New Delhi
- National Centre for Disease Control (NCDC), New Delhi
- Central Drug Research Institute (CDRI), Lucknow
- Department of Science and Technology (DST), New Delhi
- Indian Space Research organization (ISRO), Bengaluru
- Department of Biotechnology (DBT), New Delhi
- Indian Institute of Science (IISc), Bengaluru
- Other ICMR Institutes / Centres

International:

- WHO, Geneva, Switzerland
- WHO, SEARO, New Delhi
- Erasmus University, Rotterdam, The Netherlands
- Georgetown University, Washington DC, USA
- St. Olaf College, Minnesota, USA
- Lymphatic Filariasis Support Centre, Atlanta, USA.
- University of Oxford, UK.
- Smith College, USA
- Monash University, Australia

Staff Strenghth

Staff Position as on 31st July, 2020				
S.No.	**Cadre in position**	**Sanctioned Strength**	**In-position**	**Vacant**
1	Scientific Staff	29	22	7
2	Technical Staff	161	88	73
3	Administrative Staff	35	22	13
	Supporting Staff			
4	Staff Car Drivers	25	9	6
5	Multi-Tasking Staff	30	10	20
	Total	**280**	**151**	**119**

Scientists & their Current Research Areas

Sl. No.	Name of the Scientist	Area of Research
1	Dr. Ashwani Kumar Director	Vector Biology & Control, Vector Proteogenomics, Vector –Infections & Vector-Parasite Interaction, Malaria Epidemiology & Disease Burden Estimation
2	Dr. S. Poopathi Scientist-G	Medical Entomology: Biological Control of Mosquito Vectors
3	Dr. R. L. J. De Britto Scientist-F (Medical)	Clinical Epidemiology of Vbds, Clinical Trials Filariasis, Morbidity Management of Filariasis
4	Dr. R. Paramasivan Scientist-F	Molecular Detection, Characterization of Vector & Vector Borne Pathogens (Arboviruses & Rickettsia)
5	Dr. Nisha Mathew Scientist-F	Organic Chemistry, Development of Vector And Parasite Control Agents
6	Dr. S. S. Sahu Scientist-F	Malaria Epidemiology & Vector-Borne Diseases, Insecticide Resistance & Management Testing & Promoting Newer Vector Tools
7	Dr. V. Vasuki Scientist-E	Development & Evaluation of Insect Control Agents, Molecular Tools for Surveillance & Monitoring of Filariasis
8	Dr. Vijesh Sreedhar K Scientist-E (Medical)	Clinical Epidemiology of Molecular Medicine
9	Dr. A. Srividya Scientist-E	Geo-Statistical Modelling of Vector Borne Diseases & Infectious Diseases Like TB/ HIV Systematic Reviews & Meta-Analysis, Disease Burden Estimation
10	Dr. M. Muniyaraj Scientist-D	Microbiology of Insects, Gut Microbiota, Leishmaniasis, Dengue, Japanese Encephalitis, Epidemiology of Vector Borne Diseases, Nanotechnology
11	Dr. C. Sadanandane Scientist-D	Vector Biology Control With Special Reference to Tick & Mite Borne Diseases (KFD & Scrub Typhus)
12	Dr. A. N. Shriram Scientist-C	Biology & Ecology of Vectors Epidemiology & Control of Vector Borne Diseases, Lymphatic Filariasis, Malaria & Dengue
13	Dr. Rituraj Niranjan Scientist-C	Immunology and Cell Biology Of Diseases
14	Dr. P. Philip Samuel Scientist-C	Microbiology, Dengue, Tuberculosis, HIV, Immunodiagnostics
15	Dr. B. Nandha Scientist-C	Social Work, Social & Behavioral Science
16	Dr. Bhavna Gupta Scientist-C	Vector Genetics & Control
17	Dr. D. Panneer Scientist-B	Development of Molecular & Immunological Diagnostics for Vector Borne & Zoonotic Diseases
18	Dr. Suchi Tyagi Scientist-B	Vector Borne Diseases, Population Genetics, Evolutionary Genomics & Bioinformatics
19	Dr. Dinesh Raja. J Scientist-B (Medical)	Community Medicine: Epidemiology of Vector Borne Diseases
20	Dr. Prasanta Saini Scientist-B	Vector Biology & Control
21	Dr. Philip Raj Abraham Scientist-B	Microbiology, Molecular biology, Diagnostics of Vector Borne, Disease (Dengue), Infectious Disease (Tuberculosis), Surveillance of Vector Borne Diseases (Filariasis)

Released by

Professor Balram Bhargava, Padma Shri

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