PROCEEDINGS

3rd International Malaria Vector Surveillance for Elimination (MVSE) Course

Jointly presented by the Asia Pacific Malaria Elimination Network (APMEN) and Mohanlal Sukhadia University, Udaipur, Rajasthan, India

3 July 2022 – 15 July 2022

apmen ASIA PACIFIC MALARIA ELIMINATION NETWORK

malaria consortium disease control, better health

The Malaria Elimination Initiative UCSF Institute for Global Health Sciences University of California San Francisco

Leadership and Trainer Group

Professor Leo Braack

Leo Braack is a medical entomologist who spent the bulk of his career in Africa, shifting focus to the Greater Mekong Subregion since 2019. After obtaining his PhD working on the succession of insects at carrion in South Africa, Leo worked in wildlife parasitology, ecology of Ebola and Marburg viruses in Central Africa, malaria vector behaviour research and malaria control in southern Africa. He has published 97 peer-reviewed papers and five books. He is currently employed by Malaria Consortium and stationed in Bangkok, Thailand. He retains a position as Extraordinary Professor at the University of Pretoria in South Africa.

Professor Arti Prasad

Dr. Arti Prasad is currently working as Professor and Head, Department of Zoology, University College of Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India. She is also Coordinator of the Post Graduate Diploma in Public Health Entomology, the first of its kind in India. Prof Prasad also serves as Coordinator of the Department of Science & Technology Fund for Improvement for S & T Infrastructure in Universities. She completed her Bachelor, Masters (Entomology) and Doctor of Philosophy (Ph. D.) studies at the Rajasthan University, Jaipur, India. She also did her Master's degree in Business Administration (MBA) with Human Resource and International Business from Amity University, Noida in 2010. She has 36 years of experience in the areas of Research, Teaching, Training & Development. Prof Prasad is the recipient of the ISHEER Award for Environment in 1996 and 2006, Best scientist award for significant contribution to the field of Desert Ecosystem in 2013 by the National Academy of Vector- Borne Diseases, Bhuvaneshwar, and the Erasmus Mundus Euphrates European Award for higher research by Santiago University Spain to work in University of Perpignan Via Domitia, France. She has more than 80 research papers in National and International journals, 3 books, and 13 chapters contributed to different books.

Dr Ashok Kumar

Dr. Ashok Kumar works as a Research Associate in the Department of Zoology, University College of Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India. He received his B.Sc. Biotechnology degree from Mohanlal Sukhadia University in 2010. Subsequently he obtained his Master's degree in Microbiology in 2012 from Jaipur National University, Jagatpura, Jaipur, Rajasthan, India and a second Master's degree in Zoology (Entomology) in 2017 from Kota Open University, Kota, Rajasthan, India. He obtained his Ph.D. degree in Zoology from the Mohanlal Sukhadia University, Udaipur, in 2021. His current research interests are in Entomology, repellence testing using WHO Standard protocols, vector biology and bionomics and vectors surveillance, insecticide resistance mapping of vectors, microbial and biological control of vectors. He has published 17 research papers and 2 chapters in National and International journals. Dr. Kumar presented papers and posters in many National and International conferences and workshops.

Mr. Pradeep Kumar Jangir

Mr. Pradeep Kumar Jangir has worked as Researcher since May, 2019, at the Department of Zoology, University College of Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India. Currently, he is a Senior Research Fellow with 3.5 years field and research experience in insecticide resistance monitoring in dengue vectors, along with teaching. He qualified as Joint CSIR-UGC NET (JRF), DBT-NET (JRF), GATE, M.Sc. in Zoology from Mohanlal Sukhadia University, Udaipur and a Bachelor's degree from University of Rajasthan, Jaipur, Rajasthan. He is recipient of the University Gold Medal for achieving First position in Master of Science. Currently, he is receiving Senior Research Fellowship by Council of Scientific and Industrial Research for his research on monitoring insecticide resistance using WHO standard protocol. He attended more than 20 national and international conferences, webinars and workshops. He has published 3 research articles.

Mr. Girish Kumar Kalal

Mr. Girish Kumar Kalal is currently working as Ph.D. Research Scholar in the Department of Zoology, University College of Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India. He completed his Bachelor of Science degree at the Mohanlal Sukhadia University, Udaipur, Rajasthan, India in 2016 and Master's in Zoology with Entomology Specialization in 2018 from Mohanlal Sukhadia University, Udaipur, Rajasthan, India, where he also obtained a Diploma in Public Health Entomology (DPHE) in 2019. He is registered as Ph.D. Research Scholar under the supervision of Prof. Arti Prasad since 2021 in the Department of Zoology, Mohanlal Sukhadia University, Udaipur, Rajasthan, India. His current research interests are in repellency testing by WHO Standard protocols, vector biology and bionomics and vectors surveillance, insecticide resistance mapping of vectors, microbial and biological control of vectors and Nanotechnology.

Miss Ankita Kumari

Miss Ankita Kumari is a Research Scholar under the supervision of Prof. Arti Prasad, Department of Zoology, University College of Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India. She did her Bachelor of Science at the University of Rajasthan, Jaipur, Rajasthan, India in 2014. She obtained her master's degree in Microbiology from the Department of Zoology, University of Rajasthan, Jaipur, Rajasthan, India and another Master's degree in MBA (Human Resource) in 2018 from Jaipur National University, Jaipur, Rajasthan, India. Her specializations are in Microbiology and Zoology (Entomology). Her current research interests are in Vectors biology and Microbial and Biological control of vectors. She has published 7 research papers and 2 chapters in National, International journals and Conferences.

Dr. Elkhan Gasimov

Dr Gasimov joined the Global Malaria Programme in WHO HQ, as Head of Malaria Elimination Unit in April 2022. Before moving to Geneva, from 2015 until April 2022 he worked in the WHO Regional office for Europe where he led the Regional Office's work in the areas of Malaria and NTDs and supported Member States in strengthening national and sub-national capacities to keep the Region malaria free and to prevent and control vector-borne and parasitic diseases through developing and implementing policies, strategies, tools and capacities and monitoring their implementation. Has more than 20 scientific publications.

Professor Neil Lobo

Dr Lobo's research and work focuses on malaria in endemic countries. Though centered primarily on entomological drivers of transmission, his research seeks to integrate entomology with other key aspects of transmission including interventions present, epidemiology and human behavior, and weather. Through this integration of data types and the use of modelling, his research seeks to elucidate how these various factors of malaria transmission interact, better understand root causes of persisting transmission, and improve protection on a highly granular, local-level. Dr Lobo's earlier work was on transgenics and genomics, with studies then focusing on vector species compositions and bionomics, vector population biology, control and elimination strategies, and human behaviour – including large scale entomological and epidemiological trials examining multiple intervention paradigms, in multiple geographies across the world. These have spanned work in the laboratory to field-based investigations, while collaborating closely with NGOs, MOHs and academia. Research (including operational research and capacity building) is directed towards collecting cross-cutting evidence that both elucidates the understanding of, and informs decision making, strategies and policy towards protecting the world's most vulnerable people.

Professor Sylvie Manguin

Dr. Sylvie MANGUIN is a Full Research Professor at the French National Research Institute for Sustainable Development (IRD), part of the Research unit UMR-HSM (Hydro Sciences Montpellier), based at the University of Montpellier (UM), France. She has a PhD in Parasitology & Pathology from UM, France and did a post-doctorate in entomology and population genetics at USDA (US Dept of Agriculture) in Beltsville (USA). After 7 years in the USA, she gained a strong expertise on malaria vectors in Latin America. Since 1998, her research has been focused on vector-borne diseases from Southeast Asia and the Greater Mekong Subregion. She is now a leading medical entomologist and vector-borne diseases researcher whose main interest concerns mosquitoes and pathogen transmission responsible for malaria, dengue, Japanese encephalitis. She has developed studies on *Anopheles* mosquitoes from 3 continents (Asia, Africa, Americas), including molecular species identification, population genetics, phylogenetic, vectorial capacities, spatial surveillance, midgut microbiota biodiversity, salivary immunological markers, and green vector control approaches. Strong collaborations have been forged in Southeast Asia (Thailand, Cambodia, Indonesia, Malaysia, India, and China), as well as in Africa (Angola) and South America (Brazil, Venezuela, Belize). She is teaching medical entomology in France (UM), Thailand (Kasetsart University) and Indonesia (Gadjah Mada University), and since 2006, she has been the advisor of more than 30 students in Master, PhD and Post-doctorate from Thailand, Vietnam, Indonesia

and China. With an h-index of 36 (WoS June 2022), she is the author of more than 120 indexed publications, 6 book chapters, 3 books including (1) « Towards Malaria Elimination – A leap Forward » (2018, free access: https://www.intechopen.com/books/6339), (2) « Anopheles mosquitoes: New insights into malaria vectors » (2013, free access : https://www.intechopen.com/books/3092), both for which she is the Editor (IntechOpen Access), and (3) "Biodiversity of malaria in the World" (2008, John Libbey Ed.).

She was recently nominated as an expert in the working group on "vectors" at ANSES (French Agency for Food, Environmental and Occupational Health & Safety) and she is serving as expert in several international institutions (National Institute of Health, USA; Oxford University, UK; National University of Singapore; Global Biodiversity Information Facility, Denmark; Global Health & Tropical Medicine, Portugal), and member of the Editorial Boards of the Malaria Journal and Acta Tropica.

Dr. Risintha Premaratne

Dr Risintha Premaratne serves as the technical officer (Malaria) at the World Health Organization Regional Office for South-East Asia. A former director of the National Malaria Control Programme of the Ministry of Health, Sri Lanka, he played a leading role in the last stage of malaria elimination in Sri Lanka and the achievement of the WHO malaria-free certification for the country in 2016.

He is a board-certified specialist in Community Medicine and holds a bachelor's degree in Medicine and Surgery, a master's degree, and an MD in Community Medicine from the University of Colombo-Sri Lanka and a master's in Public Health in Biosecurity from Massey University-New Zealand. With over 25 years of experience in public health, he has expertise in surveillance, immunization, field epidemiology, research methods, statistics, monitoring and evaluation, program management and malaria elimination.

Dr Rajpal Yadav

Dr Rajpal Yadav is a public health entomologist and a vector control specialist with nearly 37 years of global professional experience in the field of vector-borne diseases. He currently chairs the WHO Joint Action Group on the implementation of the Global Vector Control Response and heads the pesticide management programme in the Department of Control of Neglected Tropical Diseases at WHO, Geneva. He headed the WHO Pesticide Evaluation Scheme (2009–2017) and coordinated trials of vector control products with several research institutions and strengthened their capacity. He has facilitated development of several WHO normative guidelines for product testing, pesticide management, and vector surveillance and control.

During the period 1984–2008, Dr Yadav occupied research positions at the National Institute of Malaria Research (NIMR) of the Indian Council of Medical Research in India; the last position being as Sr. Deputy Director. He established a field centre of NIMR in eastern India (Rourkela, Odisha) and headed another centre in Nadiad, Gujarat (1995–2008). There he conducted and guided research on the vector biology and integrated control of malaria, arboviral diseases, filariasis and JE in the forested, urban, industrial and agricultural ecosystems. He was deeply involved in supporting the national vector-borne disease control programme, training entomologists and public health personnel on the integrated vector management and disease outbreak containment. He was a short-term staff at the WHO regional offices in New Delhi and Cairo and at WHO HQ on several occasions (1991–2007). Dr Yadav has received a number of honours and awards and published over 110 scientific papers in national and international journals.

Dr. Ranjander Sharma

Dr RS Sharma is currently one of the Directors of the Absolute Human Care Foundation in India. Presently Dr Sharma is working as National Expert for Bio-pesticides with the United Nations Development Organization (UNIDO). Dr Sharma has worked as Director-grade Scientist, National Vector Borne Diseases Control Programme (NVBDCP) & Scientist, Head of Department of the Centre for Medical Entomology and Vector Management, National Centre for Disease Control, Government of India, Delhi. Dr Sharma has 35 years' experience in prevention & control of Malaria and other Vector Borne Diseases in India. Dr Sharma received a Research Training Grant from WHO for Advanced Entomological Technique studies at the LSHTM in 1998. He is trained in 'Advanced methods in Medical and Veterinary Vector Control' from LSHTM and Imperial College in London in 1995. WHO/TDR sponsored Dr Sharma for Molecular Biology and Human Malaria Vectors in 1993. He has been WHO Expert on Malaria Vector Control- Geneva, UNEP Expert –Stockholm Convention on DDT alternatives- Geneva, Member of Vector Control Working Group - Roll Back Malaria- Geneva, United National Industrial Development Organization (UNIDO) for IVM. He has more than 80 scientific publications and written many guidelines.

Dr. Himmat Singh

Dr Singh works as Scientist-E at ICMR-National Institute of Malaria Research, Sector 8, Dwarka, New Delhi. Dr Himmat Singh obtained his Master's (1995) from MDS, University, Ajmer, and Ph.D (1999) from JNV University, Jodhpur Rajasthan. In 1999 he joined the Indian Council of Medical Research as a Research Assistant at DMRC (now NIIRNCD), Jodhpur, Rajasthan. In 2014, he joined as a Scientist in ICMR-National Institute of Malaria Research (ICMR-NIMR) which has a mandate to find solutions to the problem of malaria through basic, applied, and operational field research. As an entomologist, he has been involved in research work on vector biology and control, insecticide resistance, and xeno-monitoring by using molecular techniques. He has focused his work on implementable research towards the reduction of the burden of vector-borne diseases through need-based studies, improve surveillance, and malaria elimination studies. During his more than 20 years of research career, he completed more than 35 extramurally funded projects. He has more than 75 publications in peer-reviewed journals. Dr. Singh has served as Expert Trainer in several national and international training courses on the new tools and techniques in vector control. He has conducted several outbreak investigations for the Government of India as an expert. His group reported Zika virus in the native population of *Aedes* from India for the first time and also demonstrated zero transmission of dengue through intervention in non-transmission season. Some of the findings of their research have been adopted for the country's vector control program. He has conducted several national and international trainings for malaria entomology to State Entomologists, Epidemiologists, MHO, CMOs, Scholars, Sanitary Inspectors, and Technicians working in public health. He has received awards for contributions to the field of Medical Entomology by SOMA, 2019 Dr. Singh is a Supervisor for Ph.D. students at several Academic universities in India and a member of National level entomological societies.

Dr. Manas Sarkar

Dr. Manas Sarkar worked as Head of Science Platform and Entomology Centre of Excellence in Reckitt Benckiser, a leading global health & hygiene company. Dr. Sarkar completed his PhD in Chemical Ecology and Molecular Insect Science. Before joining Reckitt, he worked for ISCA Inc. in the capacity of Head of Product Development. Previously, Dr. Sarkar worked for Godrej Consumer Products Ltd. in different R&D capacities and developed technologies/products for HIT, Good Knight brands. He also worked for EntoGenex Industries Sdn Bhd. a Malaysia based technology company as General Manager (Technology). He also worked for National Centre for Disease Control as Deputy Assistant Director and Defence Research and Development Organization (DRL) as senior researcher. His expertise is in product development, chemical ecology, insecticide chemistry, neurogenomics, ento-epidemiology etc. Dr. Sarkar worked extensively in collaboration with Liverpool School of Tropical Medicine (UK), Ifakara Health Institute (Tanzania), University of Glasgow (UK), University of Delhi, Institute of Chemical Technology, NCBS, KIIT, MLSU etc. He has travelled to more than 25 countries as part of his work, published 26 scientific publications, and served in the editorial board of different scientific journals, member of different societies, and expert panels from time to time.

Mr P.T. Joshi

Mr. P.T. Joshi. [M. Sc, FISCD] is a free-lance Entomologist, having retired as State Entomologist of the India National Vector-Borne Disease Control Programme. Following retirement, he served as Consultant Entomologist at State level under the World Bank Supported Malaria Control Programme, National Health Mission and Consultant State Entomologist for Integrated Disease Surveillance Programme under the Commissionerate of Health, Medical Services & Medical Research & Education [Health & Family Welfare] Gandhinagar - Govt of Gujarat State - India. After Short Course training at LSH &TM- London UK, he worked for a Malaria Control & Research Project- Surat Gujarat.

He has provided expertise for Prevention and Control of Vector Borne Diseases as Former Consultant Health, Environmental Sub-Group of Sardar Sarovar & Narmada Nigam (SSNNL)- Govt of Gujarat. Worked as Resource person for Entomological surveillance & prevention and control of vector mosquito borne diseases as well as sandfly, flea-borne and tick-borne disease.

Currently working as resource person at the faculty with GEF- UNEP Funded Project Development and Promotion of Non- POPs Alternative to DDT, TOT & pilot testing of modules to promote non-POP alternative based on IVPM- NEERI Nagpur Maharashtra. Working as Resource Person for Diploma of Public Health Entomology course and hands-on training for Vector Bio-Ecology and Vector Control at Zoology Department of University of MLSU- Udaipur, Rajasthan, India.

Mr Ramachandraraj Asokan

Mr Asokan is former state entomologist in Tamil Nadu India. He is now the President of the Public Health Entomological Society based in Chennai. His expertise is in mosquito identification, fly control activities, and rodent control measures.

Ms Shobiechah Aldillah Wulandhari

Wulan has been working at Malaria Consortium Asia since 2021 as a Technical Officer based in Bangkok. She is also heavily involved in the APMEN Vector Control Working Group activities. Before joining Malaria Consortium, she was awarded a Dr Sylvia Meek Scholarship for Entomology in 2018 to continue her Master's degree in the Faculty of Tropical Medicine Mahidol University Thailand. In 2020, she obtained a Master of Science in Tropical Medicine in the area of Medical Parasitology and Entomology. During her free time, she is also a volunteer and involved (virtually) in a public health non-profit organisation – Public Health Literature Club – focused on digital health literacy for public health students in Indonesia. Her area of interest is malaria, dengue, scrub typhus, and digital literacy.

Acknowledgments

The 3rd MVSE course was generously funded by the University of California San Francisco (UCSF) and Asia Pacific Malaria Elimination Network (APMEN). Mohanlal Sukhadia University contributed in-kind, allowing use of its lecture facilities, field and laboratory equipment. We also gratefully recognize that all course trainers, specifically Dr Arti Prasad from Mohanlal Sukhadia University, Dr Elkhan Gasimov from WHO Global Malaria Programme, Dr Roop Kumari and Dr Rinku Sharma from National Center for Disease Control, Dr Rajpal Yadav from WHO Department of Control of Neglected Tropical Diseases, Dr Sylvie Manguin from French National Research Institute for Sustainable Development, Dr Risintha Premaratne from WHO Regional Office for South-East Asia, Dr Leo Braack from Malaria Consortium, Dr Neil Lobo from University of Notre Dame, Dr RS Sharma from Absolute Human Care Foundation, Mr PT Joshi (former State Entomologist Gujarat), Mr Asokan (former State Entomologist Tamil Nadu), Dr Manas Sarkar from Reckitt Benckiser, and Dr Himmat Singh from ICMR-National Institute of Malaria Research, very generously provided their time free-of-charge.

Figure 1 Group photo with Course Participants and Facilitators in the Department of Zoology Mohanlal Sukhadia University

Acronyms

APMEN	Asia Pacific Malaria Elimination Network
ATP	Adenosine triphosphate
DDT	Dichlorodiphenyltrichloroethane
DVS's	Dominant Vector Species
ESPT	Entomological Surveillance Planning Tool
GABA	Gamma-aminobutyric acid
ITN	Insecticide-treated bed nets
kdr	Knockdown resistance
LLIN	Long-lasting insecticidal nets
malERA	Malaria Eradication Research Agenda
MEI	Malaria Elimination Initiative
MLSU	Mohanlal Sukhadia University
NMCP	National Malaria Control Programme
PMI	President's Malaria Initiative
RH	Relative humidity
UCSF	University of California San Francisco
VCWG	Vector Control Working Group
WHO	World Health Organization

Executive summary

The Asia-Pacific Malaria Elimination Network (APMEN) is mandated to provide support for the malaria elimination objectives of its 21 Member States across the Asia-Pacific Region. APMEN does so by way of close collaboration with the Asia-Pacific Leaders Malaria Alliance (APLMA) for higher-level advocacy, promoting networking and country interaction, facilitating meetings and exchanges, while APMEN also provides technical support via its three Working Groups, these being the APMEN Surveillance & Response WG, APMEN Vector Control WG, and APMEN Vivax WG.

The APMEN Vector Control Working Group (VCWG) in recent years has focused on providing support for vector surveillance capacity building, as this is a skills-set that surveys within National Malaria Control Programmes have shown to have significant shortfalls and such NMCP's have requested capacity-strengthening support. The APMEN VCWG provides such capacity strengthening through enabling selected participants to attend specialized courses such as the Diploma in Applied Parasitology & Entomology; regular webinars on topics related to vector surveillance & control; short online courses such as GIS, Strategic Planning, and Insecticide Susceptibility Course; a dedicated website as repository of information and for networking (https://orene.org/); and intensive two-week face-to-face courses on Malaria Vector Surveillance for Elimination (MVSE). Two previous MVSE courses have been held, the first one in 2018 in Kuala Lumpur hosted by the Institute for Medical Research, the second one in Bangkok hosted by Kasetsart University, and the two courses were attended by between 20-32 participants invited from across the Asia-Pacific Region. For the 3rd MVSE course, APMEN decided to adopt a more Regional approach, starting with South Asia, with the intent to rotate the course to other regions in subsequent years. Because India has the highest malaria burden in South Asia, contributing 83% of all malaria cases in the WHO SEAsia Region, APMEN recommended that this would be an appropriate country to host the course within the South Asia target area. As early as first-quarter 2020, through a consultative process we selected the University of Tamil Nadu as host, but the emergence of the Covid-19 pandemic prevented the course from proceeding in both 2020 and 2021. As the pandemic receded and travel restrictions were lifted, it became possible to schedule the course for July 2022, but the University of Tamil Nadu remained unavailable due to continuing Covid-19 limitations and we moved the venue to the second option, the Mohanlal Sukhadia University in Udaipur, Rajasthan. Host institutions were selected based on presence of appropriate infrastructure such as lecture theatres, Insectaries with multiple mosquito colonies, laboratories equipped with enough stereo and compound microscopes for at least 20 students, nearby accommodation for participants, experience in hosting groups of visiting students, plus availability of a core of skilled entomologists with strong experience in vector surveillance.

We advertised the opportunity for nominees using the APMEN contact list, to invite Country NMCP's and Partner Institutions to apply for participation in the course. Because of limited budget, the number of available slots was limited to 20 participants, and a selection process was based on prioritizing younger-generation field-level entomologists, with due regard to gender equality. Countries eligible were Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. Preferential opportunity was granted to India because of its disproportionate burden of malaria, and it was allocated 10 slots out of the

20. In the end, Afghanistan and Pakistan applicants were not able to obtain visas for India, despite significant efforts to support their applications.

The course was held from 3 to 15 July 2022, hosted within the Laboratory of Public Health Entomology in the Department of Zoology, Mohanlal Sukhadia University, Udaipur, Rajasthan, India. The Head of Department is Professor Arti Prasad, who administered and led the course with competence and kind hospitality. Professor Prasad made available her entire post-graduate complement of 18 students to provide logistical and general support in ensuring all facilities and arrangements were timeously available, and ensured that accommodation, meals and transport was professionally provided.

The course included a two-day Field Trip for exposure to different trapping techniques and vector surveys, which was done in the Banswara region. The 3rd MVSE is considered to have been a success and provided valuable training and practical experience to 20 participants from the South Asia region.

Introduction

Vector control is the single most effective intervention for achieving a reduction in malaria transmission. Such vector control must be underpinned by a thorough understanding of which vector species are present in a particular area, relative abundance of the various species, breeding site preference, feeding and resting behavior, insecticide susceptibility, data management, data interpretation, all of this then integrated into an effective vector control plan. Each of these elements requires knowledge and skills for effective data sourcing, processing and application, without which vector control programs would be wasteful and misdirected, or even completely ineffective. APMEN contributes to the malaria elimination objectives of its 21 Member States by providing various instruments for vector control capacity strengthening, such as our annual intensive two-week Malaria Vector Surveillance for Elimination (MVSE) course. Other ways in which APMEN supports capacity-strengthening is by way of information-sharing through its series of regular APMEN TechTalk Webinars, and the Online Resource Exchange Network for Entomology platform (https://orene.org) which serves as repository for case studies, news updates, opportunities, and various other data sources. We also hold an annual conference during which vector control colleagues from across the world can share information and experiences.

The Malaria Vector Surveillance for Elimination (MVSE) courses remain the flagship outputs of the APMEN VCWG. Our first such MVSE course was held in Kuala Lumpur in 2018, in collaboration with the Malaysian Ministry of Health. This was followed in September 2019 by our 2nd MVSE course, in collaboration with Kasetsart University in Bangkok. Then Covid-19 dashed our plans for the next course, which we had hoped to hold in Tamil Nadu, India, in 2020, and 2021 was also not possible for the same reason of Covid-19 restrictions. Fortunately, 2022 saw a resumption of our ability to hold these courses, and we are proud to have been able to co-host this 2022 course in collaboration with the Department of Zoology of the Mohanlal Sukhadia University in Udaipur, Rajasthan, India.

The design of the course programme is based entirely on feedback from the vector control community, mostly during Annual Meeting break-out group discussions. Based on this input from Country Partners and Partner Institutions on priority needs, courses are developed to address most of these needs. For example, during the 2021 APMEN VCWG Annual Conference (virtual), country partners and partners institutions discussed and identified the regional prioritised (entomological) training topics, and how APMEN VCWG can support to address these needs. These are summarized in the Table below:

Prioritised training needs topic	
Summary of training needs topic	**How APMEN can possibly support**
• Develop/update/revision of vector surveillance & control strategic planning • Identifying key indicators to guide vector control interventions • Community engagement and best practices • Vector sampling techniques and sample processing • Vector behaviours studies • Insecticide susceptibility tests and insecticide resistance management • Interpretation of entomological data and decision-making • Data gathering, standardization, storage and use • GIS techniques and mapping	• Support on short courses in Developing Strategic Planning for Vector Control and Surveillance. • Intensive course in Malaria Vector Surveillance • Support training on how to develop a surveillance programme using ESPT which covers entomological data interpretation, data storage, data use and decision making, and vector sampling techniques, etc. • Support on short courses in insecticide susceptibility test and insecticide resistance management. • Developing country's insecticide resistance management plan. • Training on GIS for vector surveillance • Developing publication on community engagement and best practices for malaria elimination in Asia Pacific.

Based on these expressed needs, the APMEN VCWG then developed multiple online training courses, some presenter-led and some self-help, with the main course being the two-week MVSE course which is an in-person event. For budget reasons, and also practical limitations such as number of available stereo microscopes etc, this two-week course is limited to a maximum of 25 participants.

In 2022, the Mohanlal Sukhadia University was chosen to host the 3rd MVSE Course due to availability of an ideal mix of appropriate infrastructure such as lecture theatres, insectaries with multiple mosquito colonies, laboratories equipped with enough stereo and compound microscopes for course participants, nearby accommodation, experience in hosting groups of visiting students, plus availability of a core of skilled entomologists with strong experience in vector surveillance. The 2022 course had the combination of interactive lectures in the Department of Zoology Hall, virtual lectures via online platforms, hands-on learning in the laboratory (mosquito identification and insecticide susceptibility assays), and field visits (mosquito adult and larval collection, sample handling and transferring).

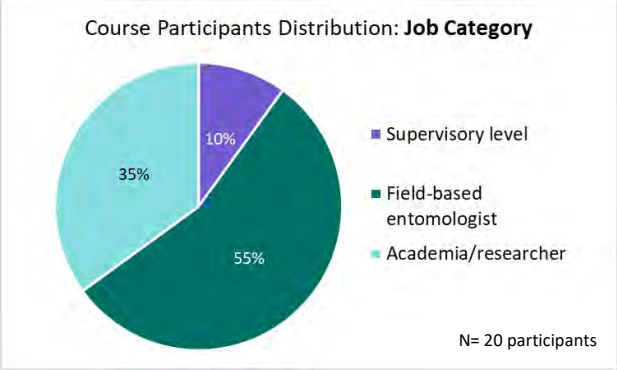

Department of Zoology

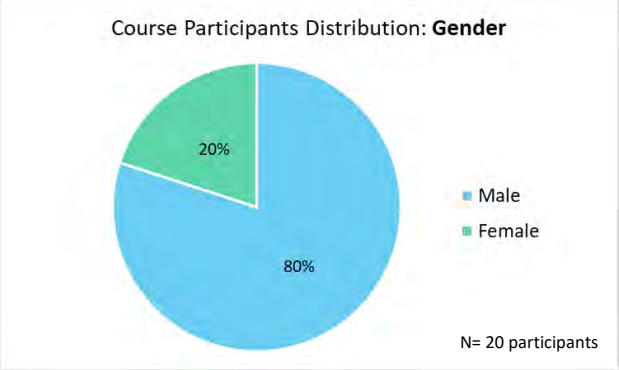
Participant selection

Twenty participants from South Asia countries were selected through a competitive process. A "Call for Applications" was announced through the APMEN Secretariat in Singapore, who sent the invitation to all Directors of National Malaria Control Programmes and also Partner Institutions in South Asia, in February 2022. This is based on a decision by APMEN in late 2019 to regionalize these two-week courses, in order to reduce travel costs per course, and offer more seats to participants in a particular region. The two-week trainings would thus be rotated on an annual basis, starting with South Asia, then the next year to Malay Archipelago, followed by Greater Mekong Subregion, and then a resumption of the cycle.

In this South Asia round, the participant selection process was based on prioritizing younger-generation field-level entomologists, with due regard to gender equality. Countries eligible were Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. Preferential opportunity was granted to India because of its disproportionate burden of malaria, and it was allocated 10 slots out of the 20. In the end, Afghanistan and Pakistan applicants were not able to obtain visas for India, despite significant efforts to support their applications. Field-based entomologist were a priority for this course as they are at the front-line of the vector control and surveillance activities.

- 55% of participants selected were field entomologists.
- 80% of course participants were male and 20% were female.
- 75% of course participants were under 40 years of age.





Course proceedings

Day 1: Sunday 3rd July 2022, Arrival and settling in

Course participants arrived in Udaipur and were met at the airport or other arrival points by staff of the Mohanlal Sukhadia University (MLSU) and conveyed to the Park Exotica Hotel, which was where all country delegates and Resource Persons were accommodated for most of the course (excluding field trip). The accommodation and facilities were of high standard, as also the restaurant which served tasty and ample Indian food and also catered for special diets such as Halal requirements. From here the delegates and resource persons were conveyed by bus and vehicles to the University each day where lectures and training events took place.

Day 2: Monday 4th July 2022, Inaugural events and course inception

The official opening of the course was initiated by a welcoming ceremony filled with warmth and goodwill, smiles and gestures of welcome by the local academic and malaria-control community, including a ceremonial "Lighting-of-the-Lamp-ceremony". **Professor Arti Prasad** (Head of the Department of Zoology and the principal host of this course in Udaipur) handed out gifts to the primary guests: Arm-bands for spirit-protection, head-wear and sashes denoting special status were kindly given to all dignitaries and Guests of Honour, and everyone made to feel welcome and comfortable. Guests of Honour were seated at a dais in the front of the conference hall and the morning was devoted to a series of opening speeches and background presentations.

Welcoming and opening speech from the Organisations Officials

Opening speech: Professor C. P. Jain, the Dean of the University College of Science, Mohanlal Sukhadia University (MLSU)

The opening warm welcome was extended to everyone by **Professor C.P. Jain**. He commented that "Prevention is better than cure" and explained the context of that in the global and national battle against malaria and was the context for what this course was all about, to provide the necessary training for a group of young entomologists to contribute towards malaria prevention. He thanked APMEN and the MLSH Dept of Zoology.

Welcoming speech: Guest of Honor Ms Chetana Bhati, Deputy Superintendent, Udaipur, Rajasthan.

As the senior representative of Police in Udaipur, Ms. Chetana Bhati explained that community awareness of malaria prevention is critical. She also explained that the Police Department was very conscious of the need to keep police premises as clear of mosquitoes as possible and devoted significant effort to that. Her speech was in Hindi.

Speech from APMEN VCWG representative: Dr Leo Braack, Co-Chair, APMEN VCWG, Senior Vector Control Specialist, Malaria Consortium

Dr Leo Braack then gave a welcome speech on behalf of APMEN (Asia-Pacific Malaria Elimination Network), expressing gratitude to all those who had contributed in many different ways to make this two-week course a reality. He explained the background of vector control, that it has been the primary strategy for malaria control ever since it was discovered in 1897 that malaria was transmitted by mosquitoes. He

briefly traced the history of mosquito control, and the failures that have arisen, and the increasing impact of insufficient entomological capacity globally. It was as a result of this global shortage of entomological surveillance skills that APMEN wishes to strengthen vector surveillance and control capacity in Asia Pacific. He wishes the country delegates well in their future endeavours.

Speech from Zoological Survey of India representative: Dr Dhriti Banerjee, Director of the Zoological Survey of India, Kolkata

Dr Dhriti Banerjee explained that the Zoological Survey was established in 1916, to monitor the biodiversity of India, with its headquarters in Kolkata. A key focus area is taxonomy and distribution of organisms. There are currently 6,4 million specimens in the collection, with over 10,000 DNA sequences. India is one of the 17 most biodiverse countries in the world. It has 96,000 Diptera specimens in the collections, including a very rich diversity of mosquito species. She further explained that vector surveillance starts with identification of specimens, then expanding to biology and lifestyle, to understand vector potential. Thus far 403 species of mosquitoes have been identified in India. They have been doing Life-Tables for vector species of malaria and dengue, to better understand when control interventions could be best deployed. They are also exploring acoustic techniques for identification of mosquito species. In addition, also doing predation studies to assess the potential role of *Toxorhynchites* mosquitoes as biocontrol agents of *Anopheles*.

Presidential Address from the Honourable Vice-Chancellor Mohanlal Sukhadia University, Udaipur: Professor I.V. Trivedi

Prof. I.V. Trivedi complimented Prof Arti Prasad on the achievements of the Department of Zoology and the Laboratory of Public Health Entomology and expressed his best wishes for the country delegates undergoing training.

Address from WHO India Country Office: Dr Roop Kumari, Technical Officer for Malaria and Vector-Borne Diseases, WHO New Delhi

Dr Kumari discussed the India National Malaria Strategic Plan. India has achieved dramatic reductions in transmission of malaria, is on track to reach zero local transmission by 2027. To strengthen surveillance, they are appointing two additional microscopists. India needs more training in surveillance and so this course is very timely and appropriate and also builds capacity within the Department of Zoology to hold more courses.

Word of welcoming on behalf of 3rd MVSE organizer: Dr R.S. Sharma, Chief Advisor, 3rd MVSE International Course

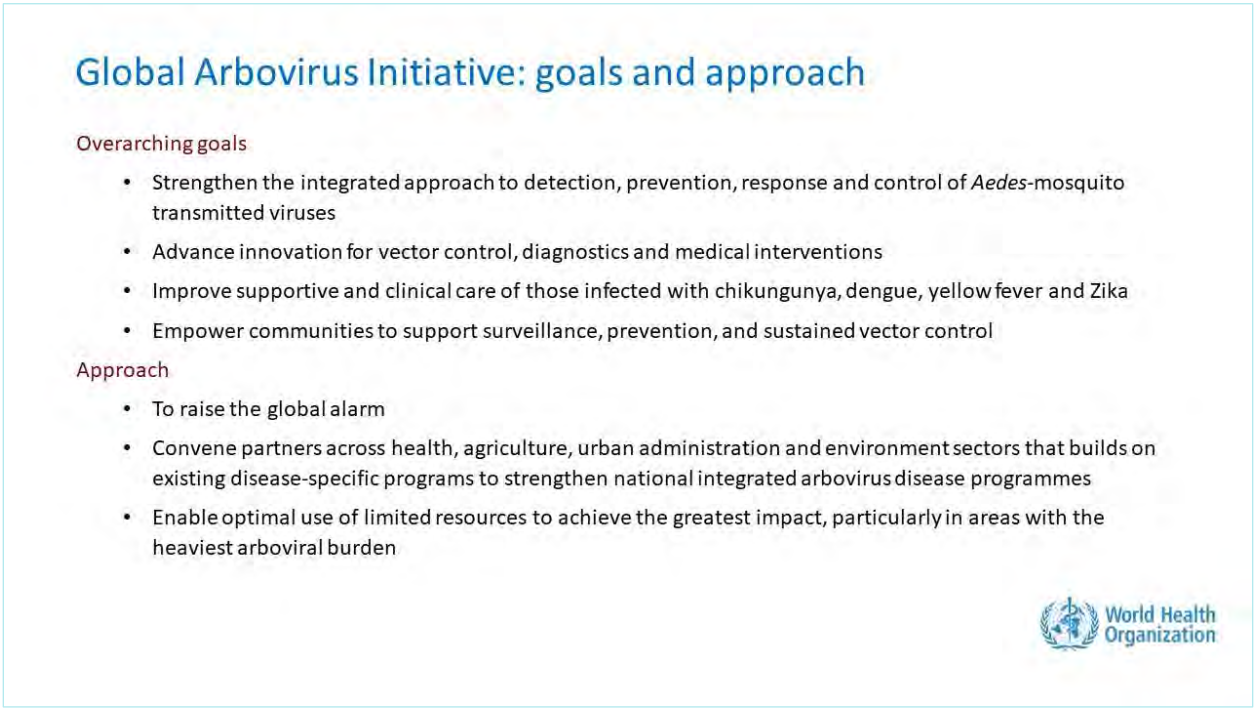
Dr Arti Prasad invited **Dr Ranjander Sharma**, in his capacity as Chief Advisor who has supported the organizing of this 3rd MVSE course to be hosted at Mohanlal Sukhadia University, to say a few words. Dr Sharma spoke about the critical shortage of medical entomologists, and thanked the various Resource Persons who agreed to undertake the training of the country delegates for training in vector surveillance.

Key presentation: Dr Rajpal Yadav, Joint Action Group for Global Vector Control Response, WHO, Geneva, *Current status of dengue globally and in Asia, and main challenges for its control*

Dr Yadav spoke about the current status of dengue globally, as well as dengue in Asia and the challenges associated with control of dengue. He introduced the subject by outlining the range of vector-borne diseases, using two categories, these being major diseases with Control/Elimination programmes associated with them (malaria, dengue, chikungunya, Zika, filariasis, schistosomiasis, and several others), and emerging/re-emerging diseases such as scrub typhus, Crimean-Congo haemorrhagic fever, West Nile fever, plague and others. He explained that today more than 80% of the world's population is at risk from at least one major vector-borne disease, with more than half at risk from two or more, and showed a map showing that the majority of these diseases are in the tropical belt straddling the planet. He then narrowed down to the main arboviruses, which are dengue, chikungunya, Zika and yellow fever. All these have *Aedes aegypti* and *Aedes albopictus* as the main vectors and he gave an overview of the global distribution of these species as well as dengue. He also provided graphic depictions of the global distribution of Chikungunya, Zika and yellow fever virus. He showed the annual number of reported dengue cases between 2010 to 2021. 2019 was the year of major dengue outbreaks in multiple countries at global scale. For dengue, 128 countries are affected by this disease, with an annual number of roughly 390 million infections, and 3.9 billion people at risk. In the Asia Region, the Philippines, Malaysia and Vietnam are the most heavily affected. The main challenges are that the burden of disease is not fully known, there is inadequate surveillance and poor reporting of cases, deaths and epidemics. The consequences of these are that compared with malaria, dengue is considered a low priority disease, and there is a poor evidence base to map country and global risk and forecast epidemic potential. Another challenge is inadequate funding, low domestic budget allocations, and donor funding is scanty and fluctuating. The consequences of these are that strong health and medical care systems are lacking in many countries, inadequate PHE capacity and trained personnel, compromised rapid response to dengue outbreaks, and a long delay to develop new tools/technologies for surveillance, prevention and control. More challenges are emerging biological threats, insecticide resistance, invasion of *Aedes* species in new territories, and multiple dengue viruses (DEN-1 – DEN-4). Consequences of these include impact on the efficacy of vector control tools, new territories are at greater risk of disease. There are also environmental challenges, such as climate & other unpredictable changes, unplanned urban development, and sanitation/solid waste management services. The consequence of this is increased risks of transmission of viruses. And then finally, another challenge is that local community engagement & inter-sectoral collaboration are not always successfully

implemented, with the consequence that there is a lack of ownership, sharing of resources and participation.

Dr Yadav then spent time explaining the Global Arbovirus Initiative. The overarching goals and approach are shown in picture below:



The Global Arbovirus Initiative rests on six pillars, which he explained. The full Powerpoint presentation can be seen at ORENE training website https://orene.org/training_tab/3rd-malaria-vector-surveillance-for-elimination-mvse/

Key presentation: Dr Elkhan Gasimov, Head: Malaria Elimination Unit, Global Malaria Programme, WHO, Geneva, *Current Status of Elimination of Malaria Globally and the Main Challenges*

Dr Elkhan Gasimov gave an overview of the current status of elimination of malaria globally. He outlined the goals of the Global Technical Strategy, and then gave an overview of the progression in malaria control and elimination success since the year 2000. From 2000 until 2015 there was steady reduction in both case numbers and mortality, but stalled in about 2015, and in 2020 increased to 241 million cases and 627,000 deaths. The High Burden High Impact initiative focused initially on the 10+1 countries (ten countries from Africa with the highest malaria burdens in the world, plus India which has the highest case numbers outside of Africa), for targeted malaria interventions. Another initiative has been the E-2020 to support malaria elimination in a specifies set of countries approaching Elimination, and this has now been superceded by a E-2025 initiative. WHO has guidelines to support Elimination, taken up in “A Framework for Malaria Elimination” document, very recently published. WHO also has guidelines for “Preparation for Certification of Malaria Elimination”.

Presentation: Dr Rinku Sharma, Joint Director, Head of Malaria Division, NCVBDC, New Delhi, *National Action Plan for Malaria Elimination in India*

Dr Rinku Sharma gave a Virtual address on the National Malaria Control Programme in India. She gave an overview of the primary vector-borne diseases in India, as summarized in the Table below:

VBDs	Malaria	Dengue	Chikungunya	Japanese Encephalitis	Lymphatic Filariasis	Kala-Azar
Area	Pan-India	Pan-India	Pan-India	24 States	20 States	
Vector	*Anopheles*	*Aedes*	*Aedes*	*Culex*	*Culex* and *Mansonia*	*Phlebotomus*

The National Malaria Control Programme started in 1953, changed to the National Malaria Eradication Programme in 1958, then the National Malaria Programme in 1998, and finally the National Vector-Borne Diseases Control Programme in 2021. Out of the 11 High Burden High Impact countries (10+1), only India has managed to achieve a reduction in malaria cases in 2020. The goal in India is to eliminate local transmission by 2027, in accordance with the National Framework for Malaria Elimination 2016-2030. During the period 2000 – 2015, malaria cases declined 44% and between 2015 to 2021 achieved a reduction of 86%. In 2021, 125 Districts reported zero indigenous cases. India contributes 77% of the total malaria cases in Southeast Asia. The country has nine vector species incriminated in transmission. Rural transmission is primarily *Anopheles culicifacies*, while urban malaria is caused by *Anopheles stephensi*. These two species are responsible for more than 70% of transmission in India.

Presentation: Dr Risintha Premaratne, Technical Officer (Malaria) WHO Regional Office Southeast Asia, *Malaria Elimination: How Sri Lanka Achieved Malaria Elimination and What is it Doing to Maintain Malaria Free status?*

Dr Risintha Premaratne then gave a presentation "Malaria Elimination: How Sri Lanka Achieved Malaria Elimination and What is it Doing to Maintain Malaria Free status?". He mentioned that India, Indonesia and Myanmar account for 98% of malaria cases in the WHO Southeast Asia Region. Bhutan and Timor Leste are very near reaching zero cases. Sri Lanka has a population of about 22 million people. It is the largest Lower-Middle Income Country located in the core malaria-endemic tropical belt to have achieved malaria Elimination. In 1935, there were an estimated 80,000 deaths due to malaria in Sri Lanka, out of a population at that time of 6 million people. In 1963, so successful had the country been in reducing transmission that only 17 cases were recorded (11 imported, 6 indigenous). That gave rise to a sense of complacency, no-one really cared about malaria any longer, and malaria surveillance and control activities virtually ceased. By 1967, there was a massive malaria resurgence, and soon cases had risen to 1,5 million again. This points to the risk of stopping malaria surveillance and control activities too soon and reducing vigilance. Malaria transmission became established and most transmission persisted in the conflict areas contested by the Army and Rebel forces, forest areas primarily. Armed forces accounted for about 85% of cases. When supplemental malaria control interventions were instituted within the Armed Forces, malaria very quickly reduced. 55% of cases were due to relapse of *Plasmodium vivax*. The actions implemented included Indoor Residual Spraying, larviciding, parasite screening and treatment, ITN's, filling up of abandoned gem-pits, etc. Transmission was also sustained by clusters of Sri Lankan workers coming and

going between Sri Lanka and Africa, thus importing malaria. Authorities strengthened active case detention around positive cases.

Presentation: Dr Ranjander Sharma, Director of Absolute Human Care Foundation, *What is a NMCP Vector Control Entomologist Expected to do: Skills needs definition an enabling tools identification*

Dr Ranjander Sharma then gave a 53-slide PowerPoint presentation on what a NMCP Entomologist expected to do, which is a broad subject, and he covered the entire spectrum in his talk. He started off by providing background context of the global malaria situation, narrowing down to the malaria burden in the WHO Southeast Asia Region, then focusing on malaria control in India as a case study on what malaria control involves. Historically control was based on three key activities, these being Insecticidal Residual Spraying (using DDT), Monitoring and surveillance of cases, and Treatment of cases. India unfortunately has a history of missed opportunity following the Global Malaria Eradication Programme, when surveillance and control activities slumped, and entomological skills were lost. Malaria control essentially became an operational "Spray-and-Pray" programme, but mosquitoes developed resistance to insecticides which would have been picked up much sooner had entomological surveillance been in place. Malaria is now "…a problem to be solved, not merely a task to be performed". In India, there were more than 1,5 million cases of malaria in 2020. In the tribal areas, infant and maternal mortality >80%. Country programmes are encouraged to adapt WHO guidelines and recommendations to suit local situations. But fundamentally, a NMCP cannot simply identify a vector control intervention tool and implement, you need entomologists to monitor the continuing efficacy of the intervention. *Anopheles culicifacies* is responsible for the bulk of rural transmission, *Anopheles stephensi* for urban transmission, and *Anopheles dirus* for outdoor transmission outside of domestic dwellings. Dr Sharma pointed out the great shortfall in entomological staffing and surveillance capacity: for State Entomologists only 31.81% or required capacity exists; for Zonal Entomologists only 51,28 % and for Insect Collectors only 63,12%. He explained the definitions of "Malaria Control", "Malaria Elimination", and "Malaria Eradication". He then outlined what a malaria entomologist is expected to do, especially the various activities under vector surveillance. Dr Sharma then moved on to discuss vector species complexes in the South Asia region and gave a short summary of how India dealt with concurrent Covid-19 and malaria and how this was dealt with, as well as the confounding effects of fever due to dengue and misdiagnoses. He described the WHO 10 priority activities for 2017-2022 in terms of vector control. From here he moved on to describe the Framework for Vector Surveillance, and what it involved, yielding various Outputs (Improved vector surveillance; Informed decision-making), Outcomes (vector control operations optimized), and Impact (Reduced disease incidence). He then outlined the WHO-recommended malaria control and prevention strategies, and the challenges which have arisen in implementing such actions. He provided a list of requirements that will contribute towards solving the problems of malaria control, as well as the Categories defining the capacity requirements for vector surveillance and control programmes, highlighting the shortfalls in multiple countries regarding Governance, Finance, Human Resources, Logistics & Infrastructure, as well as Information Systems, according to published surveys. Finally, he spent time describing the various elements of vector control, emphasizing that vector control is the single most effective intervention for achieving a reduction in malaria transmission. He outlined some of the key elements of vector control, such as anti-adult measures, anti-larval measures, biological control, environmental control, and

legislative measures. He emphasized the need for effective vector surveillance, which is the foundation for vector control interventions. The PowerPoint presentations by Dr Sharma are available at https://orene.org/training_tab/3rd-malaria-vector-surveillance-for-elimination-mvse/

Day 3: Tuesday 5th July 2022, Developing a surveillance programme with Professor Neil Lobo from University of Notre Dame, USA.

Professor Neil Lobo spent the entire day providing an excellent review and discussion on particular tools and approaches, advantages and merits, as well as guidelines for use of the Entomological Surveillance Planning Tool (ESPT) as developed by the Malaria Elimination Initiative (MEI) of the University of California San Francisco (UCSF). This ESPT was developed in close collaboration with the National Malaria Control Programmes and research institutions in multiple countries in Asia and Africa and is now being adopted by a steadily increasing number of malaria-endemic nations. Key points regarding this Entomological Surveillance Planning Tool are as follows:

• Since 2015, progress in malaria control has stalled, with plateauing and increasing transmission in many places. Understanding why and where transmission is persisting, ensuring effective vector control, and monitoring trends are critical to accelerating progress. In this context, the role of entomological surveillance is more important than ever.
• To reduce malaria burden and achieve elimination, a shift in mindset is needed toward local problem-solving. To support this shift, and in response to malaria program demand, the UCSF Global Health Group's MEI and the University of Notre Dame led the development of an Entomological Surveillance Planning Tool (ESPT).
• The ESPT aligns with and aims to distill WHO guidance into an operational decision-support tool for national malaria programs to support cost effective, locally tailored, and evidence-based vector control. The ESPT also incorporates guidance from the President's Malaria Initiative (PMI) and other technical partners and resources. The updated Malaria Eradication Research Agenda (malERA) highlights the need for minimal essential entomological data that are collectable and actionable for national malaria programs. The ESPT responds to this call by identifying and defining minimum essential indicators and advocates for program ownership of entomological surveillance activities and vector control decision-making.
• The ESPT helps to identify gaps in protection, or limitations with current prevention measures, by collecting and integrating priority entomological data with other data, such as climatic, epidemiological, and human behavioral data. This data in turn can support decisions on targeting and tailoring vector control to address the human-vector contact point (i.e., where transmission occurs). The tool also supports programs to re-orient routine entomological surveillance activities, foci and outbreak investigations, and receptivity monitoring in areas, thus preventing malaria re-establishment based on priority programmatic questions. Entomological surveillance is the collection of entomological data over space and time. In the context of malaria, entomological surveillance is essential to understand vector species composition, specific population dynamics, and behavioral traits that affect disease transmission and intervention effectiveness over time. The World Health Organization (WHO) Global Technical Strategy 2016–2030 outlines five core vector control elements to accelerate elimination (see figure below).

Entomological surveillance is central to all five elements, and data generated from entomological surveillance should guide intervention selection, targeting, tailoring, and deployment in space and time. Further, entomological surveillance can provide a framework to evaluate complementary strategies and tools. The ESPT is a decision-support tool for planning entomological surveillance activities, interpreting entomological data, and guiding programmatic vector control decisions. The ESPT prioritizes entomological surveillance indicators and activities across transmission settings, geographic areas (sentinel sites versus transmission foci), and levels of program capacity. The ESPT includes practical approaches and priority indicators (i.e., minimum essential indicators) to help answer program questions about local transmission drivers, gaps in protection with current vector control interventions (e.g., insecticide resistance, outdoor biting, etc.), and selecting supplemental vector control interventions to address gaps in protection. In turn, these data, in combination with epidemiological and other data, help programs tailor vector control solutions, reduce vector populations and human-vector contact, and drive down transmission. The ESPT also includes indicators and methods to improve understanding of human behavior as it relates to increased exposure to infectious mosquito bites, and to high-risk populations (HRPs) that may be contributing to transmission but not accessing malaria preventative and treatment services. Such indicators and methods are also considered alongside relative costs of entomological surveillance activities.

The presentations by Professor Lobo and ESPT module are available at
https://orene.org/training_tab/3rd-malaria-vector-surveillance-for-elimination-mvse/

Day 4: Wednesday 6th July 2022, Malaria vector identification

A powerful rainstorm occurred the previous night, strong wind blowing over trees which broke power lines and disrupted electrical supply to the MLSU buildings. It was therefore decided to use initiative and

rather do larval sampling exercises in the morning. The group thus travelled to the peri-urban outskirts of the city, split into three groups, and conducted larval surveys. Multiple sites were found with *Anopheles* larvae, some yielding high numbers of larvae, especially at cattle drinking-troughs. Sampling techniques were demonstrated and discussed, as well as data-recording and reporting procedures. At midday the group returned to the University, by which time electricity had been restored and it was time for the presentation by Dr Sylvie Manguin.

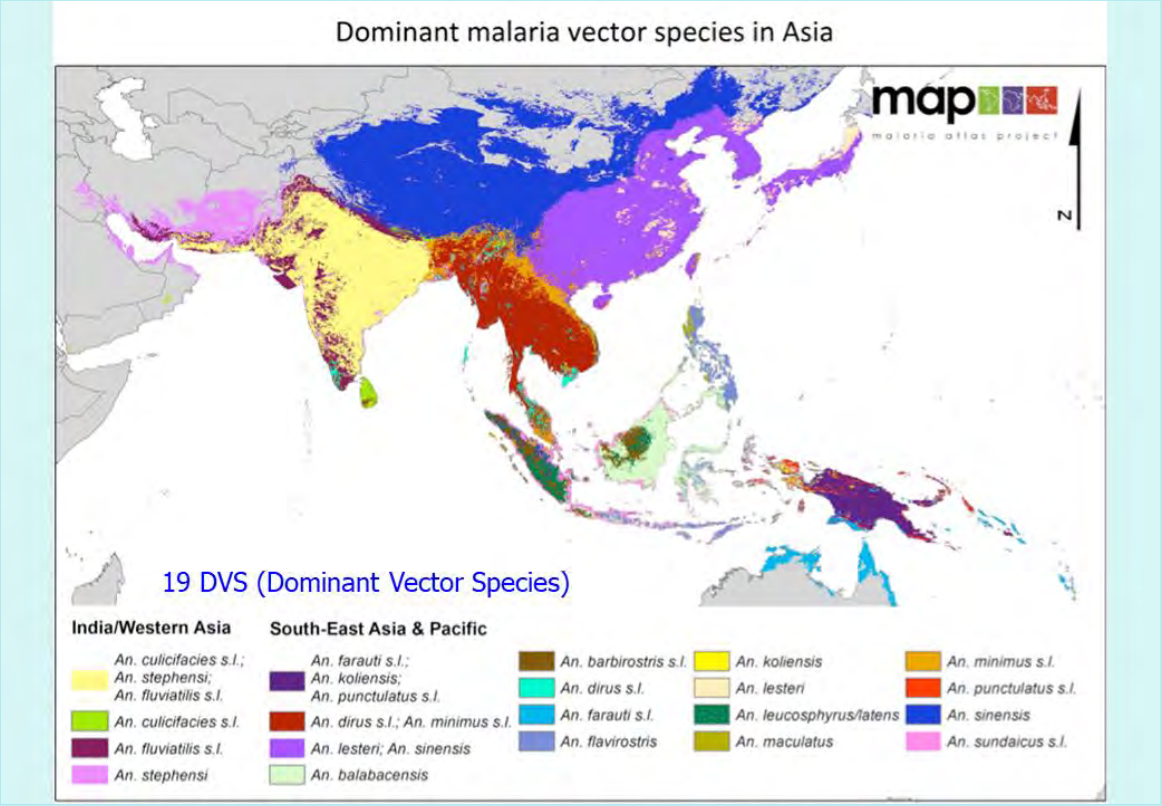

Presentation: Dr Sylvie Manguin, Research Professor at the French National Research Institute for Sustainable Development (IRD), *The need for accurate vector identification: Species complex and bionomics of dominant vectors in Asia Pacific*

Dr Manguin gave a virtual presentation that focused on malaria vectors and species complexes/groups in the Asia-Pacific region, with much associated biological and ecological information. As introductory context, she sketched the global malaria situation and the fact that malaria burden has increased in recent years, and narrowed down to a description of the situation in Asia-Pacific. She indicated that, globally, 34 countries have become malaria-free since 1962, of which 13 were since the year 2000. Vector Control is the main strategy for malaria control. Vector Control must be based on a good knowledge of the vector species and the behaviour of each vector. She then explained the essential difference between what is known as a "Species Complex" and a "Species Group":

- *Anopheles* species complex is two or more true biological species which are sibling, cryptic species and morphologically indistinguishable and require molecular techniques to identify the species;
- *Anopheles* species group comprises two or more morphologically mostly indistinguishable species, but one or more of the life-stages are distinguishable and so have to resort to molecular identification.

There are 19 Dominant Vector Species (DVS's) in the Asia-Pacific Region, most of which belong to species complexes or groups, and she showed an excellent map of the distribution of these DVS's across Asia-Pacific. In the Asia-Pacific region, each malaria vector belongs to a species complex (or group) in which sibling species are undistinguishable based on morphological characters alone, although they can present

different vectorial capacities and trophic behaviors. This situation makes vector control in Asia-Pacific more complicated as the efficacy will rely on the correct species identification.



Sylvie then spent time discussing the main complexes and groups in Asia-Pacific. The PowerPoint by Professor Manguin can be accessed at https://orene.org/training_tab/3rd-malaria-vector-surveillance-for-elimination-mvse/

Presentation: Dr Ranjander Sharma, Director of AHC Foundation, *Mosquito morphology: Microscope introduction to mosquito genera – LARVAE: Anopheles, Aedes, Culex, Mansonia, Armigeres spp.*

Dr Ranjander Sharma then gave a presentation which explained differences in morphology of larvae in the genera *Anopheles, Culex, Mansonia, Armigeres* and *Aedes*, and discussed the life stages and biology of these stages.

Day 5: Thursday 7th July 2022, Field sampling

The group travelled by car and bus to Banswara District from Udaipur. Along the way we stopped at two sites, the first being a riverine setting where the different larval sampling techniques were explained and

demonstrated, with participants practicing the techniques themselves in different habitat types. Various genera of larvae were collected, thereby demonstrating the effectiveness of these techniques. The second site was a setting of rural households, where local people were interviewed about malaria control behavior and practices, and dwellings were inspected for presence of resting adult mosquitoes (common), larvae in water containers (abundant in some), and use of bednets (people are supplied with bednets but they are not using them, in some cases nets still in original packaging, and it is clear that community engagement needed to be strengthened for improved uptake of vector control measures. Sandflies were also commonly collected.

The group settled in at the hotel in Banswara, then in late afternoon moved out again to a tribal village setting on the outskirts of Banswara, for a demonstration of adult mosquito collection techniques. The following trapping methods were demonstrated: Window Entry/Exit trap, BG Trap with artificial chemical lure, CDC Light Trap, Human Decoy Trap, Human-Baited Double Net Trap, Human Landing Catch. The group then were shown different household situations, and the CDC Light Trap was installed inside a household which had cattle inside the home in an adjoining room, thus maximizing the opportunity for mosquito catches, and the Window Entry/Exit trap was installed at another household. Handheld aspirators were also used to collect mosquitoes feeding at cattle and goats.

The group then retired back to the hotel to prepare for more field-work the next day.

Day 6: Friday, 8th July 2022, Field sampling (continued)

The group moved out from the hotel at 06:00 to the village where the CDC Light Trap and Window Entry/Exit Traps had been installed the previous night. Both traps yielded good collections of mosquitoes. Then the Pyrethrum Knockdown Catch method was demonstrated at another household, where sheets were placed on the floor, insecticide sprayed and the room vacated for 30 minutes before the sheets were examined for the presence of immobilized mosquitoes, of which several were found. Aspirator collections from walls and crevices in households also yielded good numbers of resting mosquitoes, many of which were blood-fed. The group then went back to the hotel for breakfast and refreshment.



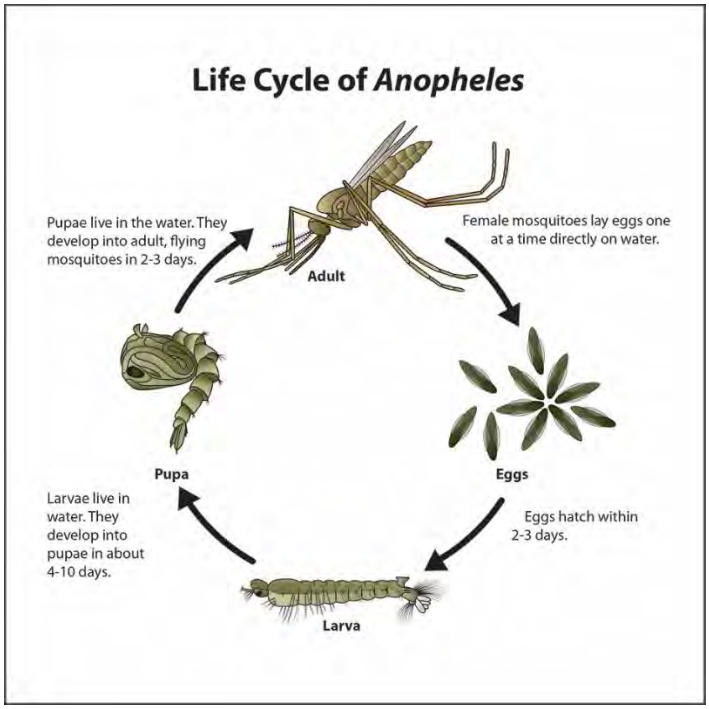
After breakfast the group moved out to yet another Tribal village on the outskirts of Banswara. Both villages (the village visited the previous night and also on this day) were inhabited by people primarily of the Bhil Tribe (90%) although some were Garasia. Here the group was split into two operational groups, each being designated an area of the village to conduct entomological surveys for about 90 minutes and report back. The groups were tasked to search for larval breeding sites, conduct searches for resting mosquitoes, interview people regarding bednet use, evaluate general living conditions and compile a summary report on entomological findings and malaria control recommendations. After due time, the groups re-assembled and gave their reports. This was followed by Question and Discussion time. At this village we saw an elderly gentleman farmer who had a sore on the back of his hand, approximately 7cm x 5cm, which he ascribed to having been caused by scratching of insect bite which then became infected by intracellular protozoa (we suspected cutaneous leishmaniasis). The group then returned to the hotel for lunch.

After lunch we had two lectures by **Mr PT Joshi**, who delivered a presentation on “Mosquito Morphology, Systematics, and Taxonomy”. He explained that Systematics is that branch of biology that deals with classification, nomenclature and taxonomy of organisms. Thus, for example, mosquitoes belong to the Family Culicidae, in the Order Diptera, within the Class Insecta, in the Phylum Arthropoda and Kingdom Animalia. There are more than 3,000 mosquito species divided into 34 genera. All Culicidae have elongated mouthparts adapted for piercing and/or sucking, the antennae are long and in the case of males are plumose, but pilose in females, and the wing venation is also characteristic of the family. The genus *Culex* is typified by having pulvillae. He then explained the various morphological features.

Source: *Anopheles stephensi* Liston, 1901, Walter Reed Biosystematics Unit (WRBU)

Source: *Culex pipiens* Linnaeus, 1758, Walter Reed Biosystematics Unit (WRBU)

Mr PT Joshi gave a second lecture which dealt with Internal Morphology, explaining the various internal organs and structures. He mentioned that females of *Anopheles* and *Aedes* have only one spermatheca, whereas *Culex* have three spermathecae and also lay may more eggs than *Anopheles* and *Aedes*. He explained the differences between Endo- and Exophagy, Endo-and Exophily, and Anthropo- vs Zoophily, adding that most *Anopheles* are not absolute in these preferences but exhibit a mix of these extremes in their behavior. *Anopheles gambiae s.s.* in Africa is the most strongly anthropophilic Anopheline species in the world which also makes it the most efficient vector.



Source: CDC website, "Life Cycle of Anopheles species mosquitoes"

Life cycle can vary from 3-6 days up to six months sometimes. Males tend to have much shorter lifespan than females and live for only a few days. Females tend to live from 4 days to mostly ten days in the case of *Anopheles culicifacies* although it can live up to 34 days for females and up to 8 days for males. Most mosquitoes will live for less than 15 days in summer and usually 17-18 days in the cooler season. Optimal

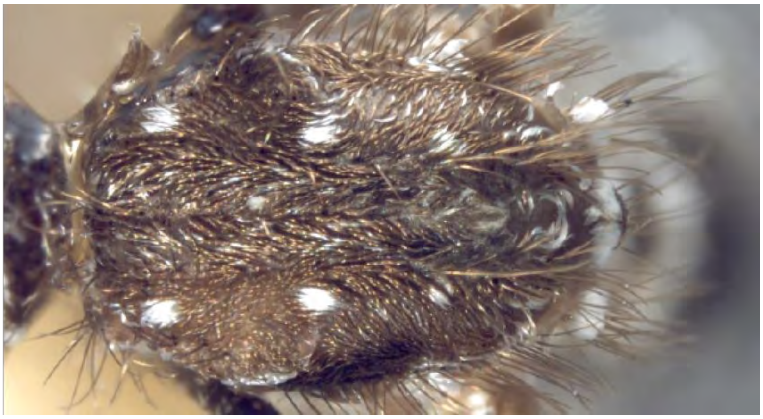
temperatures for survival are 25-30 Centigrade and a relative humidity between 60-80%. The fecundity of the females depends on the quantity and quality of ingested blood. He described the life cycle, mentioning also that the gonotrophic cycle refers to the period from blood-feeding to egg-laying. Mosquito eggs mostly hatch between 24 and 36 hours after being laid, although in the case of drought resistant *Aedes* eggs the eggs can last for a year of more before hatching.

Following these lectures, the group returned to the Tribal Village on the outskirts of Banswara Village, for more entomological field surveillance exercise and practice, eventually returning to the hotel for the final night of the field visit.

Day 7: Saturday, 9th July 2022, Field sampling (continued)

The group departed from the hotel at 08:30 back to the village they had visited the previous evening, in order to obtain a tissue scrape-sample from the gentleman who had a sore on his hand; this arose because during discussion at the hotel it emerged that cutaneous leishmaniasis had been diagnosed in the general area some years back, and the possibility existed that this could be re-emergence of such diseases as sandflies were very abundant in the particular village. Samples were collected but subsequently proved negative.

The group then drove on to Tripura Temple in Talwada Town not far from Banswara city, for a sightseeing experience at this magnificent temple. A small entomological survey for *Aedes* larval presence was also conducted, and one pool was discovered which hosted many thousands of *Aedes* larvae. Subsequent adult emergence from larval specimens collected here showed they were all *Aedes vittatus*, which is a potential dengue vector based on vector competence studies.



Source: *Aedes vittatus* scutum (Bigot, 1861), Walter Reed Biosystematics Unit (WRBU)

Day 8: Sunday, 10th July 2022, Rest and recreation

Course participants used the time to relax and catch up with emails and domestic chores such as laundry. Because of a Security Alert arising from religious extremist activities in weeks before and anticipated increase on this Eid day, participants were advised not to go into the city for shopping or sightseeing activities. Instead, time was made available on the next day, Monday 11th, for students to visit some popular shopping areas in late afternoon.

Day 9: Monday 11th July 2022, Mosquito identification

Presentation: R Asokan, Retired Chief Entomologist, Tamil Nadu, and President: Public Health Entomological Society, Chennai, *Use of dichotomous keys and microscopic identification of Regionally-important vector mosquitoes.*

Following the unfortunate withdrawal of Dr BN Nagpal for health concerns, **R Asokan** was recruited to provide training on mosquito identification using bench aids and dichotomous keys. R Asokan has a wealth of taxonomic and ecological knowledge regarding malaria vectors in South Asia and spent two days going through the various morphological features and traits that separate or cluster species groups and individual species. Opportunity was afforded for the participants to conduct their own identifications of mosquito specimens provided to them from the MLS University Insectary and specimens brought by specific participants, using microscopic and other tools as well as dichotomous keys for mosquito species of the Region.

Day 10: Tuesday 12th July 2022, Mosquito identification (continued)

Presentation: R Asokan, Retired Chief Entomologist, Tamil Nadu, and President: Public Health Entomological Society, Chennai, *Use of dichotomous keys and microscopic identification of Regionally-important vector mosquitoes (continued).*

R Asokan continued with presentations depicting characteristics of the different species groups. These presentations are available online at https://orene.org/training_tab/3rd-malaria-vector-surveillance-for-elimination-mvse/. After lunch the group moved to the laboratory, where they were provided with adult specimens of a range of *Anopheles* species that they could practice on for identification using dichotomous keys.



Presentation: PT Joshi, Retired State Entomologist India National Vector-Borne Disease Control Programme, Processing of Larval Sample.

Mr PT Joshi gave two short presentations on capture, storage and transport of adult and larval specimens, as well as pinning methods for adult mosquitoes. His presentation on Data Recording, Larval collection procedure and processing is available at https://orene.org/training_tab/3rd-malaria-vector-surveillance-for-elimination-mvse/.

Day 11: Wednesday 13th July 2022: Mosquito identification (cont.), and WHO insecticide susceptibility assays

Presentation: Shobiechah Aldillah Wulandhari, Technical Officer, Malaria Consortium Asia, *The APMEN Online Resource Exchange Network for Entomology.*

We started off the day with a presentation by **Mrs Shobiechah Aldillah Wulandhari** (Technical Officer, Malaria Consortium, Bangkok) on the APMEN Online Resource Exchange Network for Entomology (ORENE, https://orene.org). She provided an overview of the various resources available on the site, which

are numerous and include training modules, case studies, literature, latest news, latest opportunities (jobs, funding, etc), useful links, TechTalks, and many more. There is also a "*Personality of the Month*" which highlights a vector colleague in Asia-Pacific, in particular young and upcoming entomology scientists or vector control implementers. She provided the website link and encouraged everyone to register and join the site.

Following this presentation, the group moved back into the laboratory for further microscope and identification work on *Anopheles*, both adult stage and larval stage. **Dr Asokan** was available as Resource Person.

Presentation: Dr Rajpal Yadav, Joint Action Group for Global Vector Control Response, WHO, *Overview of WHO susceptibility test procedure; WHO bottle bioassay (new) and susceptibility test kits.*

After the midday lunch, we had an expert virtual presentation on the latest updated protocols of the WHO Insecticide Susceptibility test procedures, by **Dr Rajpal Yadav**, Chair: Joint Action Group for Global Vector Control Response, WHO, Geneva. Dr Yadav started his presentation with slides depicting the relative volumes of insecticides used globally for vector control, clearly showing the heavy reliance on synthetic pyrethroids. He explained the global rise in development of resistance within vectors to these pyrethroids, which could lead to control programme failures. This emphasizes the need for regular monitoring of insecticide susceptibility, and the need to have insecticide resistance management strategies. After explaining the WHO "Global Vector Control Response 2017 – 2030" and the various pillars supporting this strategic approach, he spent time on outlining key gaps and needs, as well as key definitions related to insecticide resistance. A core message was that understanding the type and level of resistance of local vector populations to insecticides in current use, or planned for use, is crucial to ensuring that effective vector control interventions are selected and their effectiveness is preserved for as long as possible. He then described the different types of bioassays and practical aspect relating to them, and spent time explaining the WHO Tube Test procedure and the newly developed WHO Bottle Bioassay, indicating the differences between the WHO Bottle Bioassay and the CDC Bottle Bioassay. Worth specific mention here is there is a new WHO manual on insecticide resistance test methods, published in 2022. This is available online at https://cms.who.int/teams/control-of-neglected-tropical-diseases/vector-ecology-and-management/vector-control/insecticide-resistance. He spent time explaining the updated discriminating concentrations of insecticides for *Anopheles, Aedes* and *Culex*, ending off by giving guidelines for the storage and use of insecticide-impregnated papers as well as how to go about procuring supplies for the WHO Tube Tests from Universiti Sains Malaysia.

Following the presentation by Dr Yadav, the group moved to the Insecticide Resistance Monitoring Laboratory to have an overview of the procedures and equipment required for the WHO Tube Bioassay and the WHO Bottle Bioassay procedures, how to insert the test papers and how to coat the bottles with the test insecticide. Students had opportunity to practice the procedures.

Day 12: Thursday 14th July 2022: Insecticide susceptibility assays

Course participants assembled once more in the Insecticide Resistance Monitoring Laboratory to insert mosquitoes into the tubes and bottles (25 specimens per container) and conduct the 60-minute knockdown reading. Participants took part in transferring mosquitoes from holding containers to the tubes and bottles, and then to remove them from the treatment containers and transfer to holding tubes and buckets for the 24-hour waiting period. All due procedures were followed, such as availability of sugar solution during the 24-hour waiting period as well as placement in 27°C and 70% RH insectary conditions.

Presentation: Manas Sarkar, Head of Science, and Global Head of Entomology, Reckitt Benckiser, India, *Insecticides and Product Testing*.

Dr Manas Sarkar gave a presentation on "Insecticides and Product Testing". He first outlined the different types of insecticides and their modes of action, also giving insight into the different kinds of insecticide resistance. Acetylcholine moves the impulse signal from one neuron to another. You need acetylcholine-esterase to then degrade or stop the signal transmission otherwise the neuron continues to release acetylcholine and you have a continuous signal being transmitted, which leads to death of the insect. Some insecticides block the acetylcholine-esterase so that continuous signal is transmitted with resultant death.

Another mode of action is knockdown resistance, or kdr. Insecticide molecules target different organ systems or pathways, such as the nervous system (insecticides that target the cholinergic system), growth & development (insecticides that inhibit chitin synthesis), energy production (electron transport system). The above knockdown resistance is due to targeting the sodium channels, resulting in interruption of the ion charges across the neuron membrane. Also have insecticides that target the GABA system, or the mitochondrial system. Chlorfenapyr is an example of the latter; it is actually a "pre-insecticide", which enters the insect body and is then transformed into an insecticide which enters the mitochondria where it stops ATP and results in disruption of energy production and death.

Dr Sarkar then spoke about insectaries and blood-feeding, mentioning Oxitec which is a commercial company with, among other places, operations in Brazil where it produces millions of sterilized mosquitoes in large insect-rearing warehouses at factory scale. However, the average research and university needs are much smaller.

Dr Sarkar explained that WHO has provided various guidelines for efficacy testing of spatial repellents, mosquito repellents on human skin, household insecticide products, for field-testing of LLIN's etc, all of which are available online under the WHO website. He advised everyone to remember that guidelines are not necessarily the same as a specific manual or methodology, and usually one has to develop your own specific Standard Operating Procedure.

He then gave an interesting discussion on how chemical companies develop insecticide molecules, then produce it in a "deliverable formulation". There are guidelines for chemical evaluation to test these formulations. First do toxicological studies in the laboratory, and candidate compounds move on to field trials. Ultimately you have to get regulatory approval for each country, to get the product registered for general use. There are various companies that produce insecticidal compounds, and include BASF, Bayer, Sumitomo. Various factors affect the quality of bio-efficacy, and can be summarized as the six "M's", which are Man, Machine, Methods, Materials, Milieu, and Management; collectively these different factors contribute to the eventual bio-efficacy of the product, the measure of which is also dependent upon the quality of the bio-analytical method used.

Presentation: PT Joshi, Retired State Entomologist India National Vector-Borne Disease Control Programme, *Methods and purposes of mosquito colony establishment & maintenance*.

Dr PT Joshi then gave a presentation on the general principles of establishing and maintaining an insectary, which was followed by rich discussions and a demonstration of equipment and conditions within the *Anopheles* Insectary within the building, especially temperature (27^{o}C ±2) and humidity control (75% ±10), lighting (12 hours light and dark cycles with artificial dawn/dusk dimming and brightening of lights). Food provisioning for larvae was also discussed at length (pulverized dog biscuit and Bakers Yeast mixed in a 3:1 ratio, with different rates of food provision for the various instars), and also frequency of washing larval basins (once a week). Other needs of larvae were also discussed, such as the depth of the water (shallow for the surface-feeding *Anopheles*, deeper for *Aedes* and *Culex* which are bottom-feeders), as well as the need to ensure constant availability of 10% sugar-solution in cottonwool for adult mosquitoes. Blood-feeding of adults was another topic extensively discussed, with consensus that membrane-feeding is the most appropriate and practical, either as chicken blood (for *Culex*) or bovine (for *Anopheles*).

Dr Ashok Kumar and Pradeep Jangir, Research Associate and Post Graduate Student, University College of Science, Mohanlal Sukhadia University, *Aedes and Anopheles insectary visit*.

Dr Ashok Kumar and **Mr Pradeep Jangir** then led the visit to *Aedes* and *Anopheles* insectary. They explained the procedure in the *Aedes* insectary which was different with *Anopheles* insectary procedure, and how the department maintains the colony of mosquitoes.

Presentation: Manas Sarkar, Head of Science, and Global Head of Entomology, Reckitt Benckiser, India, *Overview of WHO susceptibility test procedure; WHO bottle bioassay (new) and susceptibility test kits.*

Dr Manas Sarkar gave a discussion and practical demonstration of the Peet Grady Chamber, which was located next to the Insecticide Resistance Monitoring Laboratory.

The Peet Grady Chamber is used to determine the intrinsic activity of an insecticide to a target species. This is done by the application of an active ingredient to isolate toxicity for compounding effects resulting from insect behavior. The chamber has a 5.8 Cubic Feet capacity. It opens inwards to prevent test insects from being sucked out if the door is opened outwards. The chamber is used to test an insecticide product, for its kill-effect. The insecticide is introduced usually by a brief timed dose of spray, through one or two of the small windows on the side of the chamber. Then insects (50 mosquitoes for example) are released into the chamber, then record the knockdown effect by counting immobilized test insects on the white floor. Knockdown is monitored every 60 seconds for the first ten minutes, after that every 5 minutes, up to one hour after introduction of the insects into the treated chamber. Any non-coordinated movement constitutes knockdown by WHO definition. After a particular test, the chamber must be washed with a non-scented soap. The chamber should then be tested with a batch of mosquitoes to check for any residual effect. The efficacy of the test product is achieved by doing a Probit Analysis, using log-dose, using the method of Finney, either as published in 1971 or the 1979 version. It essentially tests the dose/response effect.

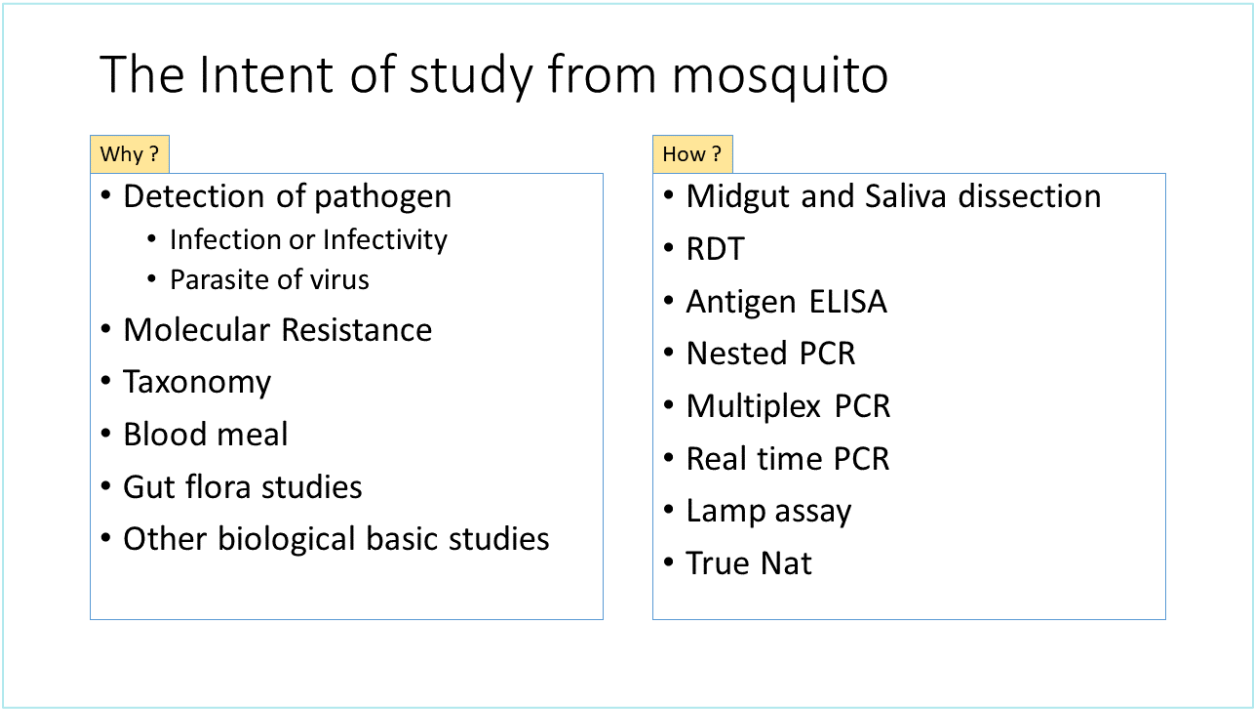
The above description is for a “free-flight” test, but you can also use caged insects, ideally a cage in each corner of the chamber. Each cage should have 25 mosquitoes. In the middle of the chamber there is a fan which can release the insecticide at a fixed dose and rate. As above, the knockdown rate is monitored over an hour, and a Probit Analysis done.

Dr Ashok Kumar and Pradeep Jangir, Research Associate and Post Graduate Student, University College of Science, Mohanlal Sukhadia University, *Culex insectary visit and artificial membrane feeding demonstration.*

Dr Ashok Kumar and **Mr Pradeep Jangir** then gave a demonstration of the *Culex* insectary, as well as a demonstration of membrane-feeding of blood-meals to the *Culex* mosquitoes. They use a hot-water bath at 37 Centigrade to warm the blood which circulates around the glass container holding the blood, with a Teflon membrane closing the glass camber which is in contact with the mosquito cage and through which the mosquitoes can suck the blood. Chicken blood is used, obtained from a slaughterhouse.

Day 13: Friday 15th July 2022: Overview of PCR and ELISA techniques for malaria vectors and parasites

Presentation: Dr Himmat Singh, ICMR, National Institute of Malaria Research, New Delhi, *Overview of PCR and ELISA Techniques for malaria vectors and parasites*



Dr Himmat Singh gave lectures on the use of Polymerase Chain Reaction (PCR) and Enzyme-linked Immunosorbent Assay (ELISA) for mosquito species and malaria parasite determination. He started off his presentation with an outline of why we study mosquitoes (species determination, pathogen detection, bloodmeal analyses, etc) and how these studies are performed (Antigen detection, Nested or Multiplex or Real-Time PCR, midgut and salivary gland dissections etc). Of interest is he mentioned that there are studies at present to develop Rapid Diagnostic Tests (RDTs) for mosquito species determination, and he explained the basic principles of how RDTs work, and the reactions involved. He moved on to explain the use of ELISA in sporozoite detection and how this is done. Mosquitoes are generally pooled in batches of

10 specimens (in case of Japanese Encephalitis pools are usually 25 specimens), and these pools are ground up in 100 microlitres of grinding buffer (or 10ml of Phosphate-buffered Saline). The assay detects antibodies against the circumsporozoite protein. He outlined the equipment and materials required to do an ELISA procedure, and the various steps that are followed during the assay process, as well as precautionary methods during processing. Finally, he summarized the advantages and disadvantages of ELISA. Dr Singh then moved on to a description of PCR methodology, outlining in detailed fashion the various steps involved and giving an example of typical results, as well as clearly explaining the differences between the different PCR techniques, finally also explaining about the Loop-Mediated Isothermal Amplification (LAMP) methodology as well as a summary overview of the "Truenat" methodology which is a chip-based microPCR test, for differential identification of *Plasmodium falciparum* and *Plasmodium vivax* parasites.

Following the presentation, Dr Singh took the course participants to the laboratory for some practical hands-on experience in grinding of specimens and other procedures.

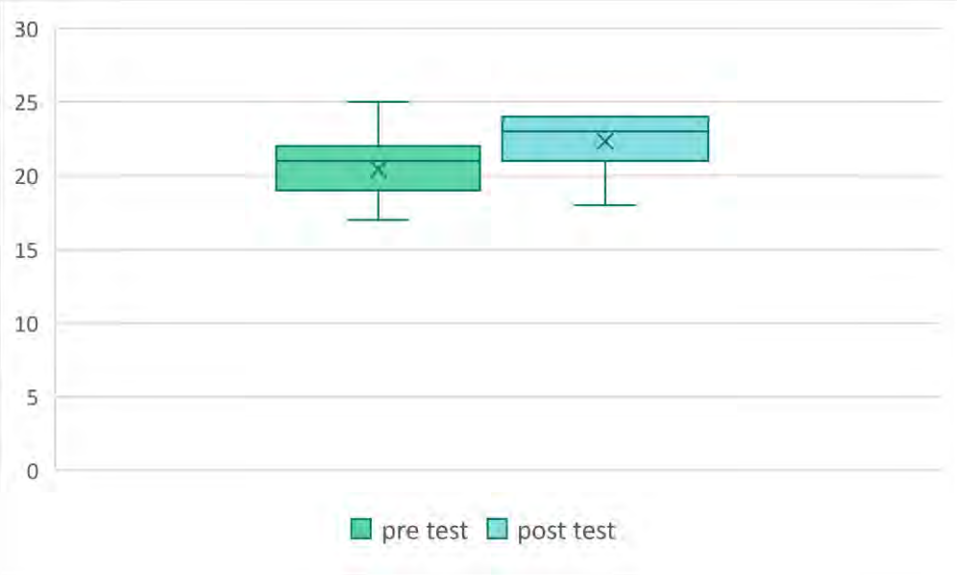
The link to access the PowerPoint slides for this presentation can be found at https://orene.org/training_tab/3rd-malaria-vector-surveillance-for-elimination-mvse/.

The course ended at lunch-time, to enable participants to commence their travels home with some weekend time to spend with family and friends after an intensive two-week course.

Course Evaluation

Knowledge assessment

A 25-question pre and post-test questionnaire was administered to the course participants in the first and last day. The pre-test questions covered topics in the training course and were used to evaluate the baseline knowledge of the participants. The same questionnaire was administered on the last day of training to assess the understanding and knowledge change after training. At baseline, 18 (out of 20) participants responded to the questionnaire. Two participants were not able to join the first day of the course due to vector-borne investigation duty. The median score of pre-tests was 21 and minimum score was 17. At the post-test, 19 participants answered to the questions and the score improved with less variations in the score compared to the baseline. The median score for post-test was 23.

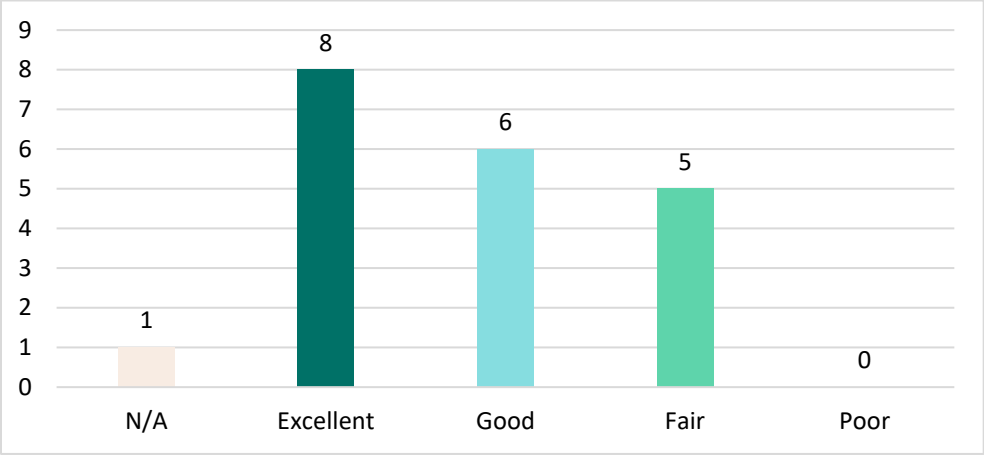


	Pre-test	Post-test
Minimum score	17	18
Q1	19	21
Median score	21	23
Q3	22	24
Maximum score	25	24

Participant feedback

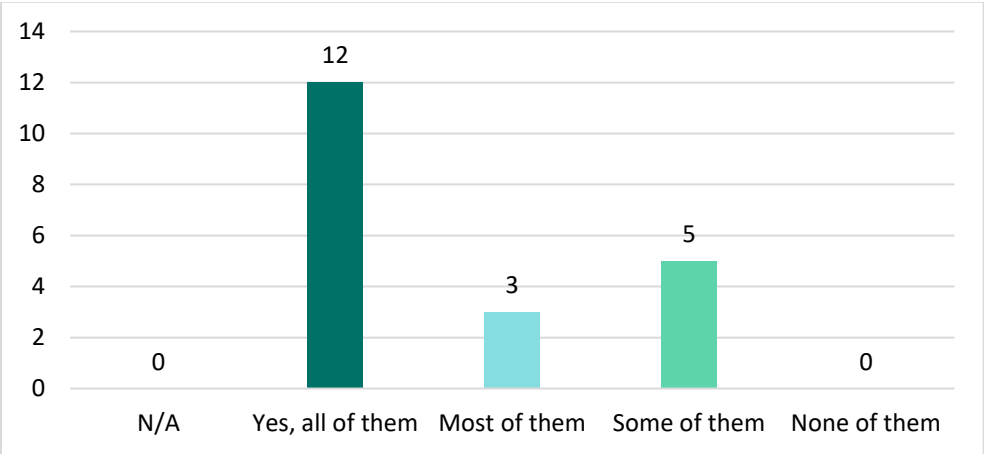
- **Overall satisfaction of the course**

Participants were asked to rate the overall satisfaction of the 3rd MVSE Course to what level they were satisfied with course held by APMEN and MLSU. Most participants rated the overall course as either 'Excellent' or 'Good'.



- **Course topic usefulness and relevancy**

Participants were asked to rate the topics usefullness and its relevancy to their entomological activities in the countries. More than half of respondents (n=12, 60%) responded 'All of the topic' were useful and relevant for them, followed by 'Some of them' (n=5, 25%) and 'Most of them' (n=3, 15%). In addition to this rating, participants also provided written feedback on what the most useful topic, they were: (1) *Developing a surveillance programme with ESPT* by Professor Neil Lobo, (2) The need for accurate vector identification: *Species complex and bionomics of dominant vectors in Asia Pacific* by Professor Sylvie Manguin, and (3) Field trip activities.



Consideration for the 4th MVSE Course

1. Content of the course

1.1. Mosquito identification

Vector identification was one of the most important topics in the 3rd MVSE. Based on the evaluation feedback form, it was suggested that the mosquito identification topic should also focus on other features of the main malaria vectors in the region, such as behavioural aspects. To get deeper taxonomic knowledge, it was suggested that more specimens and species should be provided. The host institution asked participants to bring mosquito specimens from their home countries. Some foreign participants brought specimens of different species, but due to the limited number of specimens, not all participants had access to these additional species. Also, during the practical taxonomy sessions, it would be better to have extra facilitators assisting participants during the practice.

1.2. Deeper hands-on practice

Some topics in the 3rd MVSE had quite short periods of time to practice, for instance, insecticide susceptibility assays and vector molecular identification. As countries are now widely applying molecular method to identify cryptic species of malaria vectors, it is suggested to have longer hands-on activity in using PCR (if possible).

1.3. Suggested topics from the 3rd MVSE participants

Some participants stated the need for GIS-related skills for vector surveillance. However, GIS requires much dedicated time to do justice to such a course, at least one full day, we were unable to have GIS course in the 3rd MVSE. However, the APMEN VCWG has been providing additional short course in GIS topic annualy since 2021.

In the 3rd MVSE we had participants from Sri Lanka which achieved malaria elimination and Bhutan which is in the malaria elimination phase. Course participants suggested to have specialized vector surveillance topics and tools for countries in malaria elimination phase and vector surveillance to maintain the elimination status. Community engagement was also raised during the 3rd MVSE course, as entomologists often interact with the community in terms of surveillance and control activities. It is also important to have experts that are able to make the link between lectures topic to the practical application in the vector control/surveillance programme (from research to implementation/ translational research).

2. Conduct of the course

2.1. Travel related matters

Communication related to travel, flights, and visa could be better so participants were fully supported by the contracted travel agency and the host institution. It is also important to initially screen participants' country eligibility to enter the course host country, to avoid visa problems. Due to political situation, some countries were not allowed to go into India. APMEN and host institution could provide support or allow a back up plan (shift participant allocation etc).

2.2. The need for adequate space and equipment

The need for spacious laboratory settings during taxonomic classes with at least 25 stereo microscopes are critical. A proper meeting facility should be provided and well-prepared for hybrid presentations so participants could have better interaction (Q&A and discussion) during the training with speakers who presented virtually.

2.3. Accomodation and general matters for participants' convenience should be emphasized.

A last-minute change of accommodation unfortunately occurred because of a high-level intervention for available rooms, which necessitated alternative accommodation at a high-quality hotel but at signifcantly higher cost, which meant some participants had to share rooms for budgetary reasons. Although understandable, this was clearly not an ideal situation. In terms of meals options, several participants also suggested that the host organiser prepare various meal options for the lunch box at the university and more consideration for people who are not vegetarian. A short questionnaire to profile participants' preferences needs to be considered to accommodate this. During the field visits, participants recommended the organiser to support field data collection form to capture information they got during field collection. Facilitators and speakers were suggested to give presentations with topics for a broader geographical scope, not only for South Asia region, so participants would get better understanding for vector surveillance in neighboring regions.

Annexures

Annexure 1: Course Programme

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
Sunday 3 July 2022	Whole day	Arrival of participants in Udaipur and accommodation check-in		Prof. Arti Prasad, Coordinator pf the 3rd MVSE and Head, Dept. of Zoology, MLSU, Udaipur, Rajasthan
		No formal work activities		
Day 1: Inaugural Function and Course Inception (Venue: MLSU University Guest House)				
Monday 4 July 2022 (Day 1)	07:30 – 08:30	Breakfast	Venue: Park Exotica Resort, Udaipur	
	09:30–09:35	Welcome and opening speech on behalf of Mohanlal Sukhadia University, Udaipur, Rajasthan	Dean, University College of Science, MLSU, Udaipur	
	09:35–09:40	Address by Dr Roop Kumari about malaria elimination programme in India.	Dr Roop Kumari Technical Officer- Malaria & VBD, WHO Country Office for India, New Delhi	
	09:40–09:50	Address by Dr Rinku Sharma about malaria elimination programme of NCVBDC	Dr Rinku Sharma Joint Director, Head of Malaria Division, NCVBDC, New Delhi	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
Monday 4 July 2022 (Day 1)	09:50–09:55	Welcome on behalf of APMEN	Dr. Leo Braack, APMEN	
	10:00–10:05	Speech of Chief Guest	Dr Dhriti Banerjee Director, Zoological Survey of India, Kolkata	
	10:05–10:10	Welcome and Presidential Address	Honorable Vice Chancellor Mohanlal Sukhadia University, Udaipur, Rajasthan	
	10:10–10:15	Introductions & General Outline of Course (Expectations both ways, and anticipated outcomes)	Prof. Arti Prasad Head, Dept. of Zoology, MLSU, Udaipur, Rajasthan	
	10:10–10:15	Group Photograph	MLS University Photographer	Prof. Arti Prasad Dr. Ashok Kumar
	10:10 – 10:40	**High-Tea**	Venue: MLSU University Guest House	
	10:40-11:10	Transport to lecture building for Session		
	Module 1. Background and Context (Lecture Building: Dept. of Zoology, UCoS, MLSU)			
	11:10-11:30	Initial baseline knowledge evaluation (questionnaire-based)	Dr. Leo Braack	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	11:30 – 12:15	Current status of malaria globally, main challenges globally and in Asia (virtually)	Dr. Elkhan Gasimov WHO GMP, Geneva	Dr. Leo Braack
	12:15 – 13:00	Current status of dengue globally, also Asia regionally and main challenges (virtually)	Dr. Rajpal Yadav, WHO, Geneva	Dr. Leo Braack
	13:00 – 14:00	**Working Lunch**	**Venue: Dept. of Zoology, UCoS, MLSU**	
	14:00 – 14:45	Malaria Elimination: How Sri Lanka achieved it and what it is doing to maintain it (virtualy).	Dr. Risintha Premaratne, Medical officer Malaria, WHO, SEARO	Prof. Arti Prasad
	14:45 – 15:30	What is a NMCP or other Vector Control Entomologist expected to do? Skills-needs definition and enabling tools identification	Dr. RS Sharma, Ex. Additional Director, National Centre for Vector Borne Diseases Control, New Delhi	Prof. Arti Prasad
	15:30 – 16:00	**Tea Break**	**Venue: Dept. of Zoology, UCoS, MLSU**	
	16:00 – 17:20	Developing a Work plan that addresses the entomological needs of the NMCP or Organization: Core elements.	Dr. RS Sharma,	Prof. Arti Prasad
	17:20 – 17:30	Group discussion: Recap and review of key lessons of the day	Dr. Leo Braack	Prof. Arti Prasad

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	18:00 – 20:00	**Dinner**	**Venue: Park Exotica Resort, Udaipur**	
Tuesday 5 July 2022 (Day 2)	**Module 2. Developing a Surveillance Programme (Lecture Building: Dept. of Zoology, UCoS, MLSU)**			
	07:00 – 08:00	**Breakfast**	**Venue: Park Exotica Resort, Udaipur**	
	08:00 – 08:10	Recap and participant comments on the previous day		Dr. Leo Braack
	08:10 – 09:30	Introduction to Vector Surveillance approaches	Dr. Neil Lobo, University Notre Dame, USA	Dr. Leo Braack
	09:30 – 10:00	Design and Implementation of a vector surveillance programme	Dr. Neil Lobo	Dr. Leo Braack
	10:00 – 10:30	**Tea Break**	**Venue: Dept. of Zoology, UCoS, MLSU**	
	10:30 – 12:30	Design and Implementation of a vector surveillance programme	Dr. Neil Lobo	Dr. Leo Braack
	12:30 – 14:00	Working Lunch	Venue: Dept. of Zoology, UCoS, MLSU	
	14:00 – 15:30	Design and Implementation of a vector surveillance programme (*continued*…)	Dr. Neil Lobo	Dr. Leo Braack

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	15:30 – 16:00	Tea Break	Venue: Dept. of Zoology, UCoS, MLSU	
	16:00 – 17:30	Design and Implementation of a vector surveillance programme (*continued*…)	Dr. Neil Lobo	Dr. Leo Braack
	18:00 – 20:00	**Dinner**	**Venue: Park Exotica Resort, Udaipur**	
Wednesday 6 July 2022 (Day 3)	**Module 3: Malaria Vector Identification (Lecture Building: Dept. of Zoology, UCoS, MLSU)**			
	08:00–09:00	**Breakfast**	**Venue: Park Exotica Resort, Udaipur**	
	09:30–09:40	Recap and participant comments on the previous day		Dr Leo Braack
	09:40–10:40	Mosquito morphology: Microscope introduction to mosquito genera – LARVAE: Anopheles, Aedes, Culex, Mansonia, Armigeres spp.	Dr R S Sharma	Dr Leo Braack
	10:40–11:40	Mosquito morphology and systematics: theoretical introduction	Mr PT Joshi Retd. State Entomologist, Ahmedabad, Gujarat	Prof. Arti Prasad
	11:40–12:10	**Tea break**	**Venue: Dept. of Zoology, UCoS, MLSU**	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	12:10–13:10	Mosquito morphology and systematics: theoretical introduction (*Continued*…)	Mr PT Joshi	
	13:10- 13:30	Mosquito morphology: Microscope introduction to mosquito genera – LARVAE: *Anopheles, Aedes*, *Culex, Mansonia, Armigeres* spp. (Continued…)	Dr. RS Sharma	Prof. Arti Prasad
	13:30–14:30	**Working Lunch**	**Venue: Dept. of Zoology, UCoS, MLSU**	
	14:30–15:30	The need for accurate vector identification: Species Complexes and Bionomics of Dominant Vectors in Asia Pacific (Virtually)	Dr Sylvie Manguin Research Professor, Institute of Research for Development (IRD), University of Montpellier, France	Prof. Arti Prasad
	15:30–16:00	**Tea break**	**Venue: Dept. of Zoology, UCoS, MLSU**	
	16:00–18:00	Dengue vectors*: Aedes aegypti* and *Aedes albopictus*: Adults, pupae, larvae	Dr. RS Sharma	Prof. Arti Prasad
	18:30–20:00	**Dinner**	**Venue: Park Exotica Resort, Udaipur**	
Thursday 7 July 2022	**Module 4: Field Sampling**			

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
(Day 4)	07:00–08:00	**Breakfast**	**Venue: Park Exotica Resort, Udaipur**	
	08:00–12:30	Travel to field location, settle into hotel	Dr Arti Prasad Dr RS Sharma Mr PT Joshi Dr Ashok Kumar	
	12:30–13:30	**Lunch in Field**	Dr Arti Prasad Dr RS Sharma Mr PT Joshi Dr Ashok Kumar	
	13:30–17:30	Travel to field sampling site, set up Human Double Net Trap, Human Decoy Trap, Cattle-baited Net Trap, CDC CO2-baited Light Trap, and sites for Human Landing Catches	Prof. Arti Prasad Dr RS Sharma Mr PT Joshi Dr Ashok Kumar Mr Manoj Joshi Mr Pradeep Kumar Jangir	
	17:30–18:30	**Dinner**	**Venue: Hotel**	
	18:30–22:00	Mosquito collection (rotating teams of mosquito collectors)	Dr Arti Prasad Dr RS Sharma Mr PT Joshi Dr Ashok Kumar	
	22:00	Return to Hotel		

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
Friday 8 July 2022 (Day 5)	Module 5: Sample Processing			
	08:00–10:00	Introduction to data recording, sample processing, mosquito pinning, silica-gel and other mosquito preservation/ storage techniques	Mr PT Joshi	
	10:00–10:30	**Tea break**	**Venue: Hotel**	
	10:30–12:00	Introduction to data recording, sample processing, mosquito pinning, silica-gel and other preservation/storage techniques (continued…)	Prof. Arti Prasad Mr PT Joshi	
	12:00–13:00	**Lunch**	**Venue: Hotel**	
	13:00–17:00	Travel to field site, introduction to larval collections	Prof. Arti Prasad Dr RS Sharma Mr PT Joshi	
	18:00–19:00	**Dinner**	**Venue: Hotel**	
	19:00–21:00	Processing of larval samples	Dr Arti Prasad Dr RS Sharma Mr PT Joshi Dr Ashok Kumar	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
Saturday 9 July 2022 (Day 6)	Field-trip finalization and return to Udaipur			
	09:00–13:00	Finalization of adult and larval processing, isoline preparations etc	Prof. Arti Prasad Dr Ashok Kumar Mr Manoj Joshi Mr Sanjay Kumar Meena Mr Naresh Kumar	
	13:00–14:00	**Packed lunch**	Dr Ashok Kumar Mr Sanjay Kumar Meena Mr Naresh Kumar	
	14:00–17:00	Return to Udaipur		
Sunday 10 July 2022 (Day 7)	Rest and Recovery			
		Day off, discretionary activities		
Monday 11 July 2022 (Day 8)	Module 6: Mosquito identification using bench aids and pictorial keys (Lecture Building: Dept. of Zoology, UCoS, MLSU)			
	08:00–09:00	**Breakfast**	**Venue: Park Exotica Resort, Udaipur**	
	09:00–09:30	Transport to lecture building for technical Session		

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	09:30–11:00	Use of dichotomous keys and microscopic identification of Regionally-important vector mosquitoes (ONLY South Asia Vectors)	Mr R. Asokan Retd Chief Entomologist, Tamil Nadu President, Public Health Entomological Society, Chennai	Dr Arti Prasad
	11:00-11:30	Tea break	Venue: Dept. of Zoology, UCoS, MLSU	
	11:30-13:00	Use of dichotomous keys and microscopic identification of Regionally-important vector mosquitoes (continued…) (ONLY South Asia Vectors)	Mr R. Asokan	
	13:00–14:00	Working Lunch	Venue: Dept. of Zoology, UCoS, MLSU	
	14:00-15:30	Use of dichotomous keys and microscopic identification of Regionally-important vector mosquitoes (Continued…) (ONLY South Asia Vectors)	Mr R. Asokan	
	15:30-16:00	Tea break	Venue: Dept. of Zoology, UCoS, MLSU	
	16:00-17:30	Use of dichotomous keys and microscopic identification of Regionally-important vector mosquitoes (continued…) (ONLY South Asia Vectors)	Mr R. Asokan	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	18:00–20:00	Dinner	Venue: Park Exotica Resort, Udaipur	
Tuesday 12 July 2022 (Day 9)	Module 7: Mosquito identification using bench aids and pictorial keys (continued…) (Lecture Building: Dept. of Zoology, UCoS, MLSU)			
	08:00–09:00	Breakfast	Venue: Park Exotica Resort, Udaipur	
	09:00–09:30	Transport to lecture building for Session		
	09:30–11:00	Use of dichotomous keys and microscopic identification of Regionally-important vector Mosquitoes (ONLY South Asia Vectors)	Mr R. Asokan	
	11:00 -11:30	Tea break	Venue: Dept. of Zoology, UCoS, MLSU	
	11:30-13:00	Use of dichotomous keys and microscopic identification of Regionally-important vector Mosquitoes (ONLY South Asia Vectors)	Mr R. Asokan	
	13:00–14:00	Working Lunch	Venue: Dept. of Zoology, UCoS, MLSU	
	14:00-15:30	Use of dichotomous keys and microscopic identification of Regionally-important vector mosquitoes (Continued…) (ONLY South Asia Vectors)	Mr R. Asokan	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	15:30-16:00	Tea break	Venue: Dept. of Zoology, UCoS, MLSU	
	16:00-17:30	Use of dichotomous keys and microscopic identification of Regionally-important vector Mosquitoes (ONLY South Asia Vectors)	Mr R. Asokan	
	18:00–20:00	Dinner	Venue: Park Exotica Resort, Udaipur	
Wednesday 13 July 2022 (Day 10)	Module 7: Mosquito identification using bench aids and pictorial keys (continued…) (Lecture Building: Dept. of Zoology, UCoS, MLSU)			
	08:00–09:00	Breakfast	Venue: Park Exotica Resort, Udaipur	
	09:30–11:00	Use of dichotomous keys and microscopic identification of Regionally-important vector mosquitoes (Continued…) (ONLY South Asia Vectors)	Mr R. Asokan	Dr Arti Prasad
	11:00-11:30	Tea break	Venue: Dept. of Zoology, UCoS, MLSU	
	11:30-13:00	The APMEN “Online Resource Exchange Network for Entomology”	Shobiechah Aldillah Wulandhari	Dr Leo Braack
	13:00–14:00	Working Lunch	Venue: Dept. of Zoology, UCoS, MLSU	

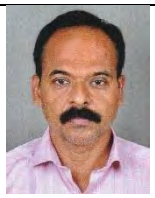
DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	Module 8: WHO Insecticide Susceptibility Assays (Lecture Building: Dept. of Zoology, UCoS, MLSU)			
	14:00–14:20	Overview of WHO susceptibility test procedure; WHO bottle bioassay (new) and susceptibility test kits	Dr Rajpal Yadav	Dr Arti Prasad
	14:20–17:30	WHO tube test and WHO bottle bioassays (4 groups: 5 delegates per group): Setting up of tubes and bottles and initial exposure of mosquitoes in tubes; coating of bottles for 24 h drying for WHO bottle bioassay (Use the WHO SOPs)	Dr Ashok Kumar Mr Pradeep Kumar Jangir	Dr Arti Prasad
	17:30–20:00	**Dinner**	**Venue: Park Exotica Resort, Udaipur**	
	Module 9: Insectary Management and susceptibility bioassays (Lecture Building: Dept. of Zoology, UCoS, MLSU)			
Thursday 14 July 2022 (Day 11)	08:00–09:00	**Breakfast**	**Venue: Park Exotica Resort, Udaipur**	
	09:30-11:00	Mosquito morphology: Microscope introduction to mosquito genera – ADULTS: Anopheles, Aedes, Culex, Mansonia, Armigeres spp. And Demonstration of different Repellency testing methods	Dr Manas Sarkar Head, Global Science Group Plc (UK), Centre of Excellence for Pest Innovation Gurgaon (India)	Dr Arti Prasad

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	11:00-11:30	Tea break	Venue: Dept. of Zoology, UCoS, MLSU	
	11:30–13:00	Exposure of mosquitoes in insecticide coated Bottles Visit to insectary, rotating groups to receive exposure to: Group 1. Demonstration of mosquito colony maintenance techniques, Mosquito feeding and colony hygiene, human ethics issues. Specialized techniques: Group 2. Forced mating & insemination, forced oviposition etc. Group 3. Membrane feeding Group5. Anopheles colony	Dr Ashok Kumar Mr Pradeep Kumar Jangir Dr Ashok Kumar Mr Manoj Joshi Mr Pradeep Kumar Jangir Mr Sanjay Kumar Meena Mr Ajay Kumar Kumawat Mr Girish Kumar Kalal Mr Naresh Kumar Mr Treelok Chand Mr Kishan Lal Dangi	Dr Arti Prasad
	13:00–14:00	Working Lunch	Venue: Dept. of Zoology, UCoS, MLSU	
	14:00–15:30	Post 24-hour insecticide exposure results: WHO tube test and WHO bottle bioassays (5 groups)	Dr Ashok Kumar Mr Pradeep Kumar Jangir	Dr Arti Prasad
	15:30–16:00	Tea break	Venue: Dept. of Zoology, UCoS, MLSU	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	16:00-16:45	Quality control of Anopheles spp. identification: demonstration and practice in transferring specimens from WHO tubes and glass bottles into paper cups; also later into micro-beam tubes for dispatch, recording form, and SOP	Mr PT Joshi	
	16:45–17:30	Methods and purposes of mosquito colony establishment and maintenance: Basic infrastructural considerations, egg, larval, pupal, adult considerations, Aedes, Culex and Anopheles.	Mr PT Joshi	
	18:30 Onwards	**Certificate & Photo Presentation, Cultural Programme and Course Dinner**		Dr Arti Prasad
Friday 15 July 2022 (Day12)	**Module 9: Insectary Management and susceptibility (Lecture Building: Dept. of Zoology, UCoS, MLSU)**			
	08:00–09:00	**Breakfast**	**Venue: Park Exotica Resort, Udaipur**	
	09:00–10:00	Recording of WHO Bottle Bioassay results Post-test/Course Evaluation	Dr Ashok Kumar Mr Pradeep Kumar Jangir	Dr Arti Prasad
	10:00–13:00	Overview of PCR and ELISA techniques for malaria vectors and parasites; visit to PCR lab	Dr Himmat Singh Scientist 'D', ICMR- National Institute of Malaria Research, New Delhi	Dr Arti Prasad

DATE	TIME	AGENDA	SPEAKER	FACILITATORS
	13:00–14:30	Valedictory and Lunch	Venue: Dept. of Zoology, UCoS, MLSU	
		Participants depart		

Annexure 2 : Course trainees

No	Country	Name	Photo	Designation/Department
1	Bangladesh	Debashis Ghosh		Assistant Coordination Manager, icddr,b
2	Bhutan	Tenzin Wangdi		Entomologist, Ministry of Health
3	Bhutan	Pema Tenzin		Malaria Technician, Ministry of Health
4	India	Dr Ashok Kumar		Researcher (Research Associate), Mohanlal Sukhadia University
5	India	Chehnang Momin		Zonal Entomologist, Ministry of Health and Family Welfare
6	India	Rajasekharan Velayudhan Pillai		District VBD Control Officer, Ministry of Health and Family Welfare
7	India	Dr Arun Sivan		State Entomologist, Ministry of Health and Family Welfare
8	India	Dr Kaushik Sanyal		State Entomologist, Ministry of Health and Family Welfare

9	India	Dr Satyendra Pandey		State Entomologist, Ministry of Health and Family Welfare
10	India	Dr Sweta Bhan		National lead consultant, Ministry of Health and Family Welfare
11	Nepal	Aradhana K C		Entomologist, Save The Children
12	Nepal	Rohit Kumar Sah		Entomologist, Save The Children
13	Sri Lanka	Thilan Fernando		Entomologist, Anti Malaria Campaign, Ministry of Health
14	Sri Lanka	Chandima Priyanthi Somarathne Hewa Weerage		Health Entomology Officer, Anti Malaria Campaign, Ministry of Health
15	India	Pradeep Kumar Jangir		Researcher (Research Fellow), Mohanlal Sukhadia University
16	India	Girish Kumar Kalal		Researcher (Research Fellow), Mohanlal Sukhadia University

17	India	Ankita Kumari		Researcher (Research Fellow), Mohanlal Sukhadia University
18	India	Naresh Kumar		Researcher (Field Assistant), Mohanlal Sukhadia University
19	India	Sanjay Kumar Meena		Researcher (Research Fellow), Mohanlal Sukhadia University
20	India	Manoj Joshi		Researcher (Research Fellow), Mohanlal Sukhadia University

Annexure 3 : Pre- and Post-Course Questionnaire

We administered a short pre-course Questionnaire at the start of the course, to establish a baseline of current understanding of basic entomological, vector surveillance and vector control knowledge. In order to assess progress, we administered the exact same questionnaire at the end of the course, to measure increase in knowledge arising from the course. The questionnaire is provided below:

3rd International Malaria Vector Surveillance for Elimination Course

Participants knowledge test

A. Your name please:.....

B. Your e-mail address please:

NB!!!!!!!Tick ONLY the box you think represents the correct answer, and ONLY one box please.

1. Tick the mosquito species that is NOT of importance in the South-Asia Region

Anopheles stephensi	*Anopheles culicifacies*	*Anopheles farauti*

2. When is *Aedes aegypti* most active?

Between dusk and midnight	Between midnight and dawn	Early morning and late afternoon

3. A fully gravid mosquito is one that...

Has eggs within her ovaries ready for laying	Is fully fed with a bloodmeal	A female that is receptive for a male

4. Alpha-Cypermethrin and Deltamethrin belong to the following class of insecticides:

Pyrethroids	Organophosphate	Carbamates	Organochlorines

5. Long-Lasting Insecticide-treated bedNets (LLIN'S) should be replaced after how many years?

One year	3 years	5 years	7 years

1

6. In female Anopheles the maxillary palps are....

Shorter than the proboscis	Longer than the proboscis	About the same length as proboscis

7. Tick the odd name from among these below, the name that doesn't fit the rest:

Culex	Phebotomus	Aedes	Toxorhynchites

8. The tarsae of a mosquito are part of which body part of a mosquito"

Head	Wings	Legs	Abdomen

9. Male mosquitoes have antennae that are far more plumose ("hairy") than the females, true or false?

True	False

10. Where would you expect to find the tergum of an insect:

Laterally	Ventrally	Dorsally

11. Where would you expect to find the pleuron of a mosquito:

Laterally	Ventrally	Dorsally

12. Where would you expect to find sternum of a mosquito

Laterally	Ventrally	Dorsally

13. Both male and female mosquitoes take bloodmeals

True	False

14. The resistance/susceptibility status of local malaria vector species should be determined before undertaking Indoor Residual Spraying

True	False

15. Mosquitoes that prefer to feed outdoors are:

endophagic	exophagic	anthropophagic

16. Mosquitoes that prefer to feed on cattle are:

Zoophilic	Anthropophagic	Endophilic

17. For the standard WHO and CDC insecticide susceptibility tests, the final definitive mortality is checked at:

60 minutes	12 hours	24 hours	72 hours	7 days

18. Plasmodium oocysts develop on the wall of the mosquito...

Salivary gland	Midgut	Proboscis	Ovary

19. Plasmodium malaria parasites can survive transovarial transmission in mosquitoes

True	False

20. Anopheles species complexes have the following characteristic:

The same degree of Anthropophily	They are morphologically very similar but genetically distinct	They are very similar in vectorial capacity

21. Parasite control, as opposed to vector control, has been the mainstay in the battle against malaria over the past century.

True	False

22. Which method is still regarded as the "Gold Standard" of malaria vector sampling?:

Human-Decoy trap	CDC light trap	Human Landing Catches

23. Anopheles larvae in a pool of water mostly...(tick the correct box)

Float with their body horizontal and parallel to the surface of the water	Float with their head down below water and tip of abdomen at the surface of the water	Stay at the bottom of the pool

24. Temperature and humidity inside the Insectary should be as close as possible to...:

20 Centigrade 95% humidity	27 Centigrade 75% humidity	34 Centigrade 50% humidity

25. How often do female Anopheles mosquitoes need a bloodmeal?:

Only once during their life, that is enough	Every time they mate with a male	For every cycle of egg-laying