REPORT: 4TH MALARIA VECTOR SURVEILLANCE FOR ELIMINATION (MVSE) TRAINING COURSE

Salatiga, Indonesia
03 - 14 July, 2023

Funded by USA Centers for Disease Control and Prevention and Asia Pacific Leaders Malaria Alliance (APLMA)
Presented by Asia Pacific Malaria Elimination Network (APMEN)
Hosted by The Institute for Vector and Reservoir Control Research and Development (IVRCRD)
Locally administered by The Indonesian Parasitic Disease Control Association (IPDCA)
Facilitated by Malaria Consortium

Executive summary

Malaria remains the most important vector-borne disease in most of the tropical parts of the world, and is a global priority for elimination. Ever since the discovery of the cause of malaria (certain *Plasmodium* parasites) and the vectors (certain *Anopheles* mosquitoes) in the late 1800's, vector control has been the single most important strategy for reduction of the malaria threat. Effective vector control is based on effective vector surveillance, to understand which *Anopheles* are present in an area, how abundant they are, do they feed indoors or outdoors, when is the peak biting period, do they rest indoors or outdoors, and are they susceptible to the insecticides used in Insecticide Treated Nets and for Indoor Residual Spraying, and similar parameters that determine effectiveness of control interventions. However, in recent decades there has been a steady loss of medical entomologists and entomological skills, and it is a source of serious concern at global level. Several publications have highlighted that Malaria Control and other vector-borne disease programs across the world suffer serious shortfalls in entomological capacity (1-5), which fundamentally impact on the ability of such Programs to achieve optimal local malaria reduction and achieve elimination milestones. It has also been raised repeatedly during the annual meetings of the Asia-Pacific Malaria Elimination Network (APMEN), with countries requesting support for capacity strengthening in basic vector surveillance techniques. For these reasons the APMEN Vector Control Working Group (VCWG) decided in 2017 to emphasize training in vector surveillance as part of its activities, to respond to the very clear needs expressed by Asia-Pacific malaria control agencies. This resulted in a series of intensive annual training courses, disrupted only by the Covid-19 pandemic. The first such course organized by the APMEN VCWG was held at the Institute for Medical Research in Kuala Lumpur, Malaysia, in 2018, the second was held at Kasetsart University in Bangkok, Thailand, the third at the University of Udaipur, India, and the most recent was held at the Institute for Vector & Reservoir Control Research & Development in Salatiga, Indonesia. The courses last for two weeks, and are now held on a rotating basis in different regions of Asia-Pacific. The typical format is for APMEN to invite the National Malaria Control Programs and also Partner Institutions (certain research institutes and universities) to nominate candidates for competitive selection to attend the course, APMEN VCWG then selects 25 potential trainees based on geographic representation, gender equity, and a focus on younger generation field entomologists, and these candidates are invited to attend the course, with all expenses covered by APMEN. There is an element of Institution-building in these courses as well, as the invited host institution gains experience in holding a high-quality international training course and exposure to international expertise by way of several global experts that are invited to function as trainers during the course.

For this 4th Malaria Vector Surveillance for Elimination course held in Indonesia, we consulted with knowledgeable vector experts within the APMEN VCWG, which includes persons from across the world, to identify an appropriate host institution in Indonesia to host the course. The Institute for Vector and Reservoir Control Research and Development (IVRCRD) soon emerged as a consensus choice to approach, and after their agreement and an on-site visit by an APMEN VCWG representative in December 2022 to assess local infrastructure and capacity, detailed discussions commenced to hold the course at the IVRCRD compound in Salatiga, Indonesia. Early in the discussions with the Indonesian Ministry of Health (MOH) they requested that they did not wish to be direct recipients of significant funds or financial responsibilities, and so an Intermediary organization (Indonesian Parasitic Diseases Control organization – IPDCA) was contracted to undertake local travel, accommodation and other

logistical arrangements, and liaise with IVRCRD to ensure all arrangement were done professionally and effectively. APMEN proceeded with the invitation and selection of the country representatives for training. In keeping with the APMEN model of conducting the courses on a geographically rotational basis, invitations targeted the Malay Archipelago for this round, and so the geographies the Borneo provinces of Malaysia (Sarawak/Sabah), Indonesia, Timor Leste, and Papua New Guinea. An exception was made to invite Pakistan and Afghanistan representatives, who for political reasons were not able to participate in the South Asia course in 2022, but as it turned out visa challenges again prevented the Afghanistan nominees from attending, although we were able to welcome two participants from Pakistan. A total of 22 country representatives were eventually able to attend, as listed in the accompanying table.

The course was held from 3 to 15 July and was a clear success. Day 1 was devoted to background presentations outlining the status of vector-borne diseases in Asia-Pacific, including malaria (Siswanto, Elyazar), lymphatic filariasis, arboviruses such as dengue, zika and chikungunya (Krishnamoorthy, Velayudhan), community engagement (Kusriastuti), how Sri Lanka achieved malaria Elimination (Harishchandra), and the history of vector control over the preceding century (Braack). Several speakers shared their knowledge remotely from places such as Geneva and Colombo, and were well received by the audience with good audience participation by way of questions and comments. Day 2 in its entirety was taken up by an excellent series of presentations on designing and implementing a vector surveillance program, presented by Prof Neil Lobo from the University of Notre Dame in the USA, who has a wealth of practical experience from his surveillance work in Africa and Asia. During the late afternoon of Day 2 we also had an hour-long excellent presentation by Prof Sylvie Manguin on mosquito species complexes and groups, and the dominant vector species in Asia-Pacific including bionomics. Day 3 saw the start of the multiple days that would be spent on mosquito identification aspects, this day being devoted to mosquito morphology, introduction to the main general of mosquitoes (*Anopheles, Aedes, Culex, Mansonia, Armigeres*, etc). On Day 4 the group travelled by mini-bus to the small city of Magelang, and from there to the village of Komboran where we placed multiple CDC light traps as well as human double net traps, an animal-baited net (buffalo), and did human landing catches until ten pm before returning to our hotel in Magelang. Early the next day we returned to Komboran to empty the human double net trap and animal baited trap of mosquitoes before sunrise, and did a pyrethrum knockdown catch as well as Prokopack and hand-aspirator collections of resting mosquitoes. Time was spent demonstrating and practicing mosquito larval collections, before returining to the hotel for sample processing. On Day6 the group travelled back to Salatiga, but made a memorable stop at the Borobudur temple, the biggest Buddhist temple in the world and dating back to the 9th century. Sunday 9th July was a Day-Off for participants to catch up with emails, laundry and other chores, before resuming training again on Day 8 which was entirely devoted to learning the use of Dichotomous Keys for identifying mosquitoes, as was also Day 9; the group also benefitted from a lecture by Dr Tanya Russel (PacMOSSI, Australia) on morphology, behavior, disease transmission and control of *Aedes aegypti* and *Aedes albopictus*. Multiple pinned specimens of different *Anopheles* species were available for participants to use for practice. On Day 10 we introduced the participants to some other genera of mosquitoes again, and then launched into the description and demonstration of insecticide susceptibility monitoring and the WHO tube tests, bottle bioassays and cone bioassays. Day 11 was spent on further demonstration of the insecticide resistance testing, as well as demonstration of insectary establishment and maintenance as well as related issues of forced mating of certain

mosquitoes, blood-feeding of mosquitoes etc. Our Gala Dinner took place in the garden of our hotel, with memorable displays of traditional dancing and singing and shared good spirit of new friends and comraderie, as well as handing out of the Course Photo and Certificates. The final day, Friday 14th July, was spent on an overview of PCR and ELISA techniques, and the Post-Course Evaluation, the course coming to an end at lunchtime. Not only did the participants learn a great deal, but they made regional friends and established networks that would benefit them in years ahead.

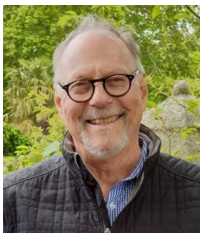
Acknowledgments

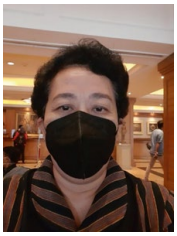
The 4th MVSE course was generously funded by the US Centers for Disease Control (CDC), Health Security Partners (HSP), and the Asia Pacific Malaria Elimination Network (APMEN), which supported the travel-related costs of participants and the course trainers and facilitators. The IVRCRD contributed much towards the course, allowing us to use its institutional facilities and laboratories free of charge and professionally prepared and led the field activities. We gratefully acknowledge the pro-bono expert training contributions from Dr Rita Kusriastuti from IPDCA, Dr Bagus Febrianto, Mrs Maria Agustini, Mrs Siti Alfiah and facilitators from IVRCRD, Dr Neil Lobo from the University of Notre Dame, Indiana, Dr Raman Velayudhan and Dr Rajpal Yadav from Department of Control of Neglected Tropical Diseases of World Health Organization (WHO), Geneva, Dr Syarifah Liza Munira and Dr Siswanto from Health Policies Development Agencies, MoH Indonesia, Dr Ferdinand J Laihad from the National Malaria Elimination Assessment from the UNICEF Indonesia, Dr Iqbal Elyazar from the Oxford University Clinical Research Unit Indonesia, Dr. K Krishnamoorthy from WHO SEARO, Dr Jeevanie Harishchandra from Anti-Malaria Campaign of the Ministry of Health in Sri Lanka, Dr Sylvie Manguin from the French National Research Institute for Sustainable Development (IRD), Dr Triwibowo Ambar Garjito from the National Research and Innovation Agency, Indonesia, Mr Mujiyono who is retired from the IVRCRD, and Mr Boni Sebayang from James Cook University. We also thank the Armed Forces Research Institute of Medical Sciences (AFRIMS) Thailand and the Papua New Guinea Institute of Medical Research who provided us with *Anopheles* specimens for training purposes.

Acronyms

ACT – Artemisinin-Combination Therapy
APLMA – Asia-Pacific Leaders Malaria Alliance
APMEN – Asia-Pacific Malaria Elimination Network
DHP – Dihydroartemisinin-Piperaquine
ELISA – Enzyme-Linked ImmunoSorbent Assay
ESPT – Entomological Surveillance Planning Tool
GMS – Greater Mekong Subregion
IVM – Integrated Vector Management
LLIN's – Long-Lasting Insecticide Nets
IRS – Indoor Residual Spraying
ITNs – Insecticide-Treated Nets
IVRCRD – Institute for Vector & Reservoir Control Research & Development (Indonesia)
IPDCA – Indonesian Parasitic Diseases Control Association
MMEP – Mekong Malaria Elimination Programme
NMCP – National Malaria Control Programme
RBM – Roll Back Malaria
PCR – Polymerase Chain Reaction
PMI – Presidents Malaria Initiative
RDT – Rapid Diagnostic Test
UCSF – University of California San Francisco
VCWG – Vector Control Working Group
WHO – World Health Organization

Leadership and Trainer Group

Leo Braack, PhD 	**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 98 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.
Dr Rita Kusriastuti 	**Dr. dr. Rita Kusriastuti, M.Sc**, is the Chair of the Indonesian Parasitic Disease Control Association (IPDCA), which has 22 branches in Indonesia. Her most recent position was in the Ministry of Health is as Director of Vector Borne Diseases Control, responsible for malaria, dengue, Lymphatic Filariasis & STH, zoonotic and vector Control program. She has served the government from 1981 and retired in 2014. She has worked as WHO Medical staff officer in NTDS unit - WHO SEARO New Delhi, consultant of One Health in USAID and Senior Consultant and Technical Coordinator Project – UNDP She is currently a Health Consultant and has worked on several projects for UNDP, USAID and WHO, and now for Malaria Consortium for this MVSE training. Her educational background includes being a Medical Doctor, she took a master's degree in epidemiology and as FETP student in Public Health Faculty, and received training on communication in John Hopkin University Baltimore USA and in Curtin University, Australia. She finished her Doctoral Degree in UGM, majoring on Health Policy and Epidemiology of Malaria toward Malaria Elimination 2030. Currently she is a member of Technical Working Group of Malaria, Expert Committee on Dengue and Task Force for LF& STH.

Dr. Bagus Febrianto, MSc 	**Dr. Bagus Febrianto, MSc** completed his degree in the Faculty of Medicine Tarumanegara University, Jakarta. After graduating from medical school, he worked at the Kuala Pembuang Health Center in East Kotawaringin regency, Central Kalimantan province. After 2 years at the Health Center, his assignment was completed as a non-permanent employee. He was successfully accepted in 2002 as an employee at B2P2VRP Salatiga/Institute for Vector and Reservoir Research Development (IVRCRD) and his career started as a government health worker. After being accepted in 2002, in 2006 he served in the management ranks as head of the research technical services sub-sector. After 6 years Dr Febrianto was transferred as head of the cooperation and information network sub-sector in 2012. In 2014 he was promoted as Head of Programs and Cooperation. In 2017 he was transferred as Head of Administration, and then appointed as head of the non-permanent office until now.
Maria Agustini, SKM, MPH 	**Maria Agustini** received her Master of Public Health degree in Field Epidemiology Training Program from Gadjah Mada University. She was appointed as the Head of Counselling at Salatiga Health District Office from 1995-1999. Her career then continued in IVRCRD as researcher in 2007-2009, Head of Finance in 2014-2017 and Head of Administrative from 2017-present.
Siti Alfiah, M.Sc 	**Siti Alfiah, M.Sc.,** graduated from Medical Entomology Magister, Gadjah Mada University, Indonesia, and has worked at the Institute for Vector and Reservoir Control Research and Development (IVRCRD), MoH Republic of Indonesia, since 2005. She studied vector bioecology, entomology, insecticide testing, and vector-borne disease epidemiology. She took "The Workshop on Household Insecticide Product Evaluation" at the Vector Control Research Unit School of Biological Sciences University Sains Malaysia (2013) and "Malaria Prevention and Treatment for Infants, Children, and Pregnant Women in Eastern Indonesia Short Course" at the University of Melbourne (2018). From 2019 to 2021, she was the coordinator of IVRCRD's research services and facilities. Since 2021, she has served as the coordinator of the IVRCRD's program planner and collaboration network.

Shobiechah A Wulandhari, MSc (Trop. Med.) 	**Shobiechah A Wulandhari** has worked at Malaria Consortium Asia since 2021 as a Technical Officer and is 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 studying for a master's degree in the Faculty of Tropical Medicine Mahidol University Thailand. In 2020, she obtained a Master of Science degree in Tropical Medicine in the area of Medical Parasitology and Entomology. During her free time, she is also a volunteer and involved in a public health non-profit organisation – Public Health Literature Club – focused on digital health literacy for public health students in Indonesia. Her areas of interest include malaria, dengue, scrub typhus, and digital literacy
Dr. Siswanto 	**Dr. Siswanto** is currently working as Senior Health Policy Analyst at Health Policy Development Agency, Ministry of Heath, Republic of Indonesia. Formerly, he worked as Senior Adviser Science Research and Innovation, WHO South-East Asia New Delhi 2021-2022. Before moving to WHO SEARO, he was assigned as DG of National Institute of Health Research and Development (NIHRD) 2016-2020. Prior to such an assignment, he was assigned as Director of R&D Center of Clinical Epidemiology, NIHRD (2012-2015) and Applied Technology and Director of R&D Center of Food and Nutrition, NIHRD (2011-2012). As a researcher, his interest is health policy and system research (HPSR). When in the position of DG of NIHRD, he took the leadership on Indonesian Total Diet Study, Indonesian Basic Health Survey (Riskesdas), Indonesian Disease Vectors Study, Indonesian Ethno-pharmacology Study, and other national scale studies.

Dr. Ferdinand Johanis Laihad DMM, MPHM 	**Dr Ferdinand Laihad,** malariologist from Indonesia, has spent over 25 years in malaria prevention and control. He worked as Technical Officer, Malaria at the World Health Organization South East Asia Region (WHO SEARO) for three years and in that position, he provided technical and operational support to national health authorities of countries in the Region for malaria control and returned back to Indonesia to work with UNICEF as Health Specialist (Malaria) to support UNICEF Malaria Staff in Aceh, Sulawesi, Papua, Maluku, North Maluku, and NTT for 3 years as well as technical support to National Malaria Control Program in Indonesia (April – Dec 2015), After completing the work with UNICEF Dr. Ferdinand Laihad did national consultancy works as a Malaria expert for Entomology study in Indonesia by University Hasanuddin, Makassar (2014), Senior National Consultant for Health System and Advocacy, UNICEF Jakarta (2015), Thematic Desk Review for Joint Malaria Program Review (JMPR), WHO Indonesia (2016), National Consultant, technical assistance on acceleration for Malaria elimination, UNICEF Jakarta (2017-2018), Senior Consultant for Development of National Strategy for Malaria Elimination 2020-2024, UNICEF Jakarta, Indonesia (2019-2020), Provincial Supervisor for Covid response in West Java Province, Center for Indonesia's Strategic Development Initiatives (CISDI), Jakarta, Indonesia (2021), National Consultant to Support the Malaria Elimination Audit in Cross Border Districts Between Indonesia and Timor-Leste (2021), National Consultant to Support the Mid-Term Malaria Program Review (MTMR) of Indonesia as A National Coordinator (2022). Currently, he is the Vice Chair of, the Indonesian Parasitic Control Association, since 2016, and also a Executive Board Member of the Association of Regional Health Authority (ADINKES) Indonesia, since 2020, and Chair of the National Malaria Elimination Assessment Committee, since 2014.

Dr. Iqbal Elyazar 	**Dr Iqbal** leads the Geospatial Epidemiology and Biostatistics Group at the Oxford University Clinical Research Unit Indonesia. He earned a BSc in Statistics from the Bogor Agricultural Institute, MPH in Health Informatics from the University of Indonesia, and DPhil in Malaria Disease Mapping from Oxford University. For 23 years, he concentrated on biostatistics, disease surveillance, and spatial epidemiology. His main areas of interest in research are big data analysis in population health, geographic analysis of infectious and non-infectious diseases, estimates of the burden of diseases, and the effects of population mobility on the spread of infectious diseases. He finished a training fellowship in public health and tropical medicine from the Wellcome Trust. He received Scholarship Award on attending Leadership Course: Science of Eradication provided by the Institute for Global Health, Barcelona, Swiss Tropical Public Health Institute and Harvard School of Public Health. Barcelona, Spain. He also served as the Indonesia Country Coordinator for the Global Burden of Diseases Study at the Institute for Health Metric and Evaluation, University of Washington. He has been a member of the Malaria Technical Working Group since 2014, serving the Indonesian Ministry of Health and The Global Fund for AIDS, TB, and Malaria. He offered technical advice on malaria epidemiology, data management, epidemiological data, and geospatial analytics to the Indonesian Ministry of Health, the World Health Organization, and provincial and district health offices.
Dr. Raman Velayudhan, MSc, PhD 	**Dr Raman Velayudhan** is Head of the Veterinary Public Health, Vector Control and Environment unit, Department of Control of Neglected Tropical Diseases of WHO in Geneva. He is the global focal point for dengue prevention and control, Integrated Vector Management, and also coordinates general arboviral vector-borne disease control activities at WHO. Dr Velayudhan has worked in the Solomon Islands, Fiji and the Philippines, then for the Govt of India at the Vector Control Research Centre, Pondicherry, which is a WHO collaborating centre. He then joined WHO in 1989 and his expertise includes malaria control, filariasis elimination and control of soil-transmitted helminths and schistosomiasis. He has steered the development of multiple documents and guidelines for WHO.

Dr. Khrishnamoorthy 	**Dr. Krishnamoorthy** is Regional Consultant for Lymphatic Filariasis, associated with the WHO SouthEast Asia Regional Office. He has more than 40 years of experience in the field of vector borne diseases. His areas of expertise include Medical Entomology and Health economics but he has been involved in a wide range of operational research on vector borne diseases and their control and elimination. Specifically relating to the topic of his presentation today, he has conducted a number of research projects on control and elimination of lymphatic filariasis, with support from WHO, and with the LF/NTD support centre in the USA. His research interests are in vector biology, ecology, and control; development of monitoring and evaluation protocols for interventions in controlling/eliminating VBDs; integrated vector management, and capacity building in vector control.
Jeevanie Harishchandra, PhD 	**Dr Jeevanie Harishchandra** is an Entomologist at the Anti-Malaria Campaign of the Ministry of Health in Sri Lanka. Dr Harishchandra supports the development of guidelines for malaria entomological surveillance and vector control for Sri Lanka and participates in decision-making on vector control and use of insecticides for malaria prevention at national level. She also worked on the process towards getting Sri Lanka certified as malaria free. During her 16 years of service she has worked through all the phases of the fight against malaria in Sri Lanka including control, pre-elimination, elimination and prevention of re-establishment. Jeevanie obtained her MSc from the University of Kelaniya in Sri Lanka, and completed her PhD studies in Medical Entomology based on the Sterile Insect Technique (SIT), at University of Kelaniya, Sri Lanka in 2022. Jeevanie has extensive experience in entomological surveillance and vector control activities as well as laboratory entomological activities and has won a merit award from the National Research Council of Sri Lanka for her work on malaria.

Dr Neil Lobo 	**Prof Neil Lobo** is associated with the University of Notre Dame in the USA, but his research and work takes him to malaria-endemic countries all over the world. Though centered primarily on entomological drivers of transmission, his research aims to integrate entomology with other key aspects of transmission including existing interventions, epidemiology and human behavior, and also weather factors. Through this integration of data types and the use of modelling, his research strives to clarify how these various factors of malaria transmission interact, to better understand root causes of persisting transmission, and improve protection on a highly granular, local-level. He has expertise in transgenics and genomics, vector species bionomics, vector population biology, control and elimination strategies, and human behavior – including large scale entomological and epidemiological trials examining multiple intervention paradigms, in multiple geographies across the world. His work covers all aspects from laboratory to field-based investigations, collaborating closely with NGOs, MOHs and academia. Fundamentally, he wants to help protect the world's most vulnerable people.
Dr Sylvie Manguin 	**Dr. Sylvie Manguin** is a Full Research Professor at the French National Research Institute for Sustainable Development (IRD), based at the University of Montpellier, France. She has a PhD in Parasitology & Pathology from UM, and did a post-doctorate in entomology and population genetics at USDA (US Dept of Agriculture). Since 1998, her research has been focused on vector-borne diseases from Southeast Asia and the Greater Mekong Subregion. She is now a internationally-leading medical entomologist and vector-borne diseases researcher whose main interest relate to mosquitoes and pathogen transmission involving malaria, dengue, and Japanese encephalitis. She has led and been involved in studies on Anopheles mosquitoes from 3 continents (Africa, Americas, and Asia specifically Thailand, Cambodia, Indonesia, Malaysia, India, and China), including molecular species identification, population genetics, phylogenetic, vectorial capacities, spatial surveillance, midgut microbiota biodiversity, salivary immunological markers, and green vector control approaches. Dr Manguin now teaches 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.

Dr Triwibowo Ambar Garjito 	**Triwibowo Ambar Garjito** is a researcher in medical entomology at the Vector-borne and zoonotic research group, Research Center for Public Health and Nutrition, National Research and Innovation Agency, Indonesia. He completed his Bachelor of Science degree in the Biology Faculty, at Gadjah Mada University, Yogyakarta, Indonesia, in 2000, and his Master's in Tropical Medicine at the Master Program of Tropical Medicine, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, in 2007. He obtained his Ph.D. in Biology in Health from the Doctoral School of Biology and Chemistry for Health (ED-CBS2) at the University of Montpellier (UM), France, in 2020. Currently, he is a Senior researcher in Medical and Molecular Entomology interested in the systematic and dynamic transmission by mosquitoes of vector-borne diseases, particularly malaria, Dengue, Chikungunya, Japanese encephalitis, Lymphatic filariasis, Zika, and Plague. He has experience in the field for more than 22 years, both in entomological studies (especially mosquitoes), epidemiology of vector-borne diseases, and zoonoses, as well as in assisting in the investigation of mosquito-borne disease transmission and control of outbreaks caused by Malaria, Dengue, Chikungunya, JE, and Zika in Indonesia. He is developing research studies on the dynamic transmission and epidemiology of Vector-borne and zoonotic disease, molecular mosquito species identification, Entomological Inoculation Rates, vectorial capacities, and entomological surveillance within a network of collaborations in Indonesia and Southeast Asia. He also has a position as an adjunct lecturer in medical entomology in the Faculty of Medicine, Public Health, and Nursing at Gadjah Mada University (UGM) in Indonesia. He is a member of the scientific advisory board of the Exeins Health Initiative (EHI) (exeins.org). He has been involved in the formulation and preparation of guidelines for nine national policies in the field of vector-borne diseases in Indonesia since 2017. He has a Scopus h-index of 5 with more than 40 national and international publications (https://scholar.google.com/citations?user=geSkFBoAAAAJ&hl=id).

Mr Mujiyono 	**Mr Mujiyono** is a Senior entomologist from the Institute for Vector Reservoir Control Research and Development in Salatiga, which falls under the National Institute of Health Research and Development in the Ministry of Health. He has worked here from 1982 to 2022, with a focus on Mosquito studies. He learnt much of his practical entomology under the mentorship of Dr. Gopaldas Pradan (WHO), and also worked with Achim Kaiser (Kabs, Germany) and Dr. Erica Mc. Alister (National History Museum, London). He did training on larval-mosquito morphology and identification at the Universiti of Science, USM, Malaysia. As a senior entomologist, he was part of various research projects in almost all regions of Indonesia, until he finally retired in 2022. Nevertheless, he still continues to be part of some malaria research projects in some regions.
Dr Rajpal Yadav 	**Dr Rajpal Yadav** is a public health entomologist and vector control specialist with 37 years of global professional experience in 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. Over the period 1984–2008, Dr Yadav occupied research positions at the National Institute of Malaria Research (NIMR) in India, also as the Sr. Deputy Director. He established a field centre of NIMR in eastern India (Odisha) and headed another centre in Gujarat There he conducted research on the vector biology and integrated control of malaria, arboviral diseases, filariasis and JE. He became involved with the WHO regional offices in New Delhi and Cairo and at WHO HQ on several occasions, then made the jump to WHO headquarters in Geneva.

Mr Boni Sebayang 	**Mr. Boni Sebayang** is a Ph.D. candidate from James Cook University, Australia. He completed his undergraduate in Biology minor in molecular biology at Universitas Padjadjaran, Bandung, Indonesia in 2010 and Master of Medical Science majoring in Future Leaders in Tropical Research at James Cook University, Australia in 2020. In his professional carrier, he has worked as a research assistant at Malaria Pathogenesis Unit at the Eijkman Institute for Molecular Biology and entomology laboratory supervisor at International SOS – Freeport site, Timika, Papua. Currently, He is joining the Mosquito-Borne Disease Group, Australian Institute of Tropical Health and Medicine, Australia which is led by Prof Tom Burkot. His current research focuses on outdoor mosquito behaviour in North Sumatra, Indonesia and Torres Strait Island, Australia. He has published 14 research articles as co-author and first author.

PARTICIPANT SELECTION

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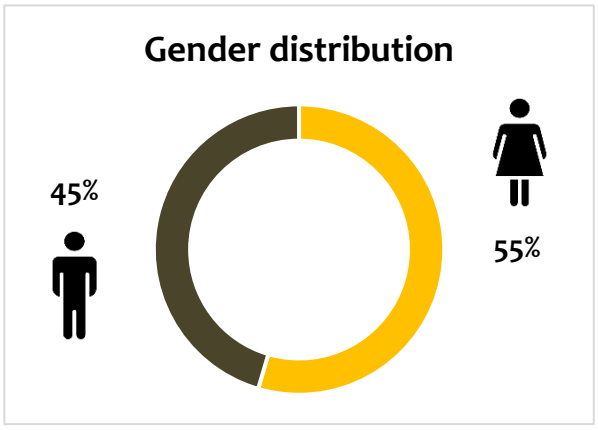
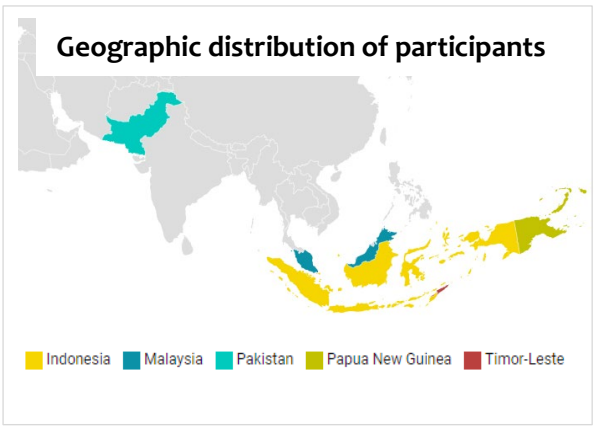
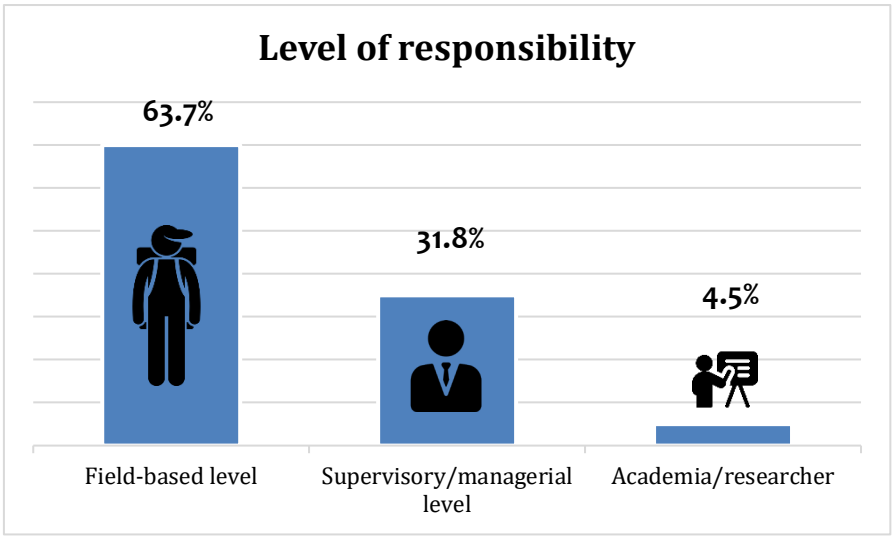
Participant selection

Twenty-two participants from the Malay Archipelago region were selected through a competitive process. A “Call for Applications” was announced to Malay Archipelago country partners and partners institutions in March 2023. The selection process prioritized younger-generation field-level entomologists, with due regard to gender equality. Countries eligible were Indonesia, Malaysia, Timor Leste, and Papua New Guinea. We invited Pakistan participants due to visa challenges preventing them from participating in the previous MVSE course in India in 2022. Preferential opportunity was granted to Indonesia because of its disproportionate burden of malaria in the region, and it was allocated 14 slots out of the 22. Field-based entomologists were a priority for this course as they are the front-line of the vector control and surveillance activities. The ratio of female and male participants was 11:9.

- 63.7% of the selected participants were field-based entomologists.
- 95,5% of the selected participants were from the government agency and either work within or closely with the National Malaria Control Programme.







COURSE PROCEEDINGS

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Course proceedings

Sunday 2nd July 2023

Our 22 country nominees arrived in Salatiga from their respective five countries of origin, and settled in at the Grand Wahid Hotel, their home for the next two weeks. The hotel is of high standard, with comfortable rooms and good meals, and good quality wi-fi connectivity throughout the hotel. Our conference organizers were able to negotiate a special tariff which allowed our participants to be placed in this superior hotel.

Day 1: Monday 3rd July 2023

Our two-week training event commenced in the spacious conference room of the Grand Wahid Hotel, with traditional ceremonial handing of honorific flower garlands to special guests, followed by welcoming speeches by dignitaries from government and Indonesian institutions. These included Dr Syarifah Liza Munira (Head: Agency for Health Policies Development, Ministry of Health, Indonesia) who formally opened the meeting, Dr Bagus Fabrianto (Head: Institute for Vector and Reservoir Control Research & Development - IVRCRD), Dr Rita Kusriastuti (Head: Indonesian Parasitic Diseases Control Association - IPDCA). Dr Leo Braack welcomed the participants on behalf of APMEN/APLMA. The participants each introduced themselves briefly, followed by a short presentation on Safety and Security arrangements during the course, then each participant was requested to fill in a 25-question short survey to assess average Pre-Course Baseline Knowledge which would serve as a comparative measure against which knowledge improvement from the course would be assessed by way of a similar Post-Course survey. A Group Photo was then taken before the tea-break.

Figure 1 Course opening by the representative from Ministry of Health Indonesia (the lady sits in the center)

Dr Siswanto (Senior Health Policy Analyst, Health Development Policy Agency, Ministry of Health, Indonesia) gave a presentation on the "**Epidemiology of Malaria globally and in the Asia-Pacific**". Dr Siswanto gave an excellent overview of the global malaria situation, then focusing on Asia-Pacific, then Western Pacific, before spending some time on the Global Framework for Malaria Elimination by 2030. For the global history, he discussed the fascinating origins of malaria from anthropoid apes in Africa, through ancient history, introduction of malaria into the Americas, the story of Cinchona, discovery of malaria parasites as cause of malaria and also the parasite life cycle in mosquitoes in the late 1800's, advent of targeted vector control, through to the initial successes in malaria reduction pre-2015 and the

relative stall in progress at that time. He then showed charts to depict the global malaria burden by region, and the relative contribution of various countries to the global burden of morbidity and mortality. He showed that in SouthEast Asia, malaria contributed 2.2% of the global cases in 2021, with a 76% reduction in cases over the past 20 years, but a spike of 400,000 cases between 2020 and 2021. Dr Siswanto showed case numbers in several countries such as India, Indonesia and Myanmar, as examples of progress and challenges over time, and the same for the Western Pacific Region. Dr Siswanto then spent some time explaining the situation in the Greater Mekong Subregion and the impact of the Mekong Malaria Elimination Programme (MMEP), in which remarkable progress has been achieved in consistent reduction of cases to near-Elimination, and indeed full Elimination in China which is now certified free of indigenous transmission. Moving the focus to Papua New Guinea, there is still relatively high transmission of malaria occurring in that country, with both *Plasmodium falciparum* and *P vivax* being a problem. Solomon Islands is also facing challenges with malaria reduction. Dr Siswanto finished off with a slide on the Global Framework for Malaria Elimination, stating that Innovation in the global framework covered (i) Research and development for malaria elimination and eradication, (ii) Operational research, and (iii) Establishing regulatory environment for malaria elimination.

Dr K Krishnamoorthy (Regional WHO SEARO Consultant for Lymphatic Filariasis) gave an extensive presentation on "**Current Status of Lymphatic Filariasis, Japanese Encephalitis, and Chikungunya in Asia**", with very good detail and explanation. He first focused on Lymphatic Filariasis (LF), outlining the various parasites that cause the disease and the mosquito vectors involved. He provided context on the global and regional distribution and prevalence (169 million infected globally, 50% of these in SEAsia), and the WHO strategic guidance to achieve LF eradication by 2020, now modified to 2030, through use of Mass Drug Administration of Ivermectin, Dec and Albendazole, 8.6 billion treatments thus far reaching more than 910 million people. He explained the different levels of achievement in disease burden reduction in different regions and countries of Asia and Western Pacific. He provided an excellent Table that summarized the parasites and vectors per country. Moving on to Japanese Encephalitis (JE), Dr Krishnamoorthy explained that JE is the main cause of viral encephalitis in many countries of Asia with an estimated 68 000 clinical cases every year, with *C. tritaeniorhynchus* as the primary vector, and that the case-fatality rate among those with encephalitis can be as high as 30%; permanent neurologic or psychiatric sequelae can occur in 30%–50% of those with encephalitis. JE transmission occurs in 24 countries in Asia and the Western Pacific, either nationally or in endemic areas. Globally, the vast majority of cases occur in the Southeast Asia region, followed by the Western Pacific. He provided a pie-chart which compared the number of cases of multiple NTD's, in relation to the overwhelming burden of malaria. For JE, India is the most heavily impacted country in the world. With regard to Chikungunya (CHIKV), the main vectors are *Aedes aegypti* and *Aedes albopictus.* CHIKV was first identified in Tanzania in 1952, then recorded in Thailand in 1967 and in India 1970s. Since 2004 CHIKV has shown a more frequent and widespread occurrence, and is now reported from over 110 countries in Asia, Africa, Europe and the Americas, but it us underreported and undiagnosed. WHO supports countries to conduct surveillance and control of arboviruses through the implementation of the Global Arbovirus Initiative (GLAI), which was launched in March 2022 and has six Pillars: (1) Monitor risk and anticipate (2) Reduce epidemic risk (3) Strengthen vector control (4) Prevent and prepare for pandemics (5) Enhance innovation and new approaches (6) Build a coalition of partners. The America's are the most heavily impacted by CHIKV, followed by Southeast Asia and Western Pacific.

Dr Rita Kusriastuti (Head: IPDCA) gave a presentation on "**The Importance of Effective Community Engagement for Entomologists**". She started off with an explanation of the key elements of a successful partnership between the National Malaria Control Programme (NMCP) and malaria-affected communities, with multiple factors including Trust, Collaboration, Teamwork and Planning together with other elements all contributing to success. She then gave an outline of the progress achieved by Indonesia in its Malaria Elimination objectives, and the milestones set for Regions and Provinces to collectively achieve Malaria Elimination by 2030. Indonesia is currently in its 2020-2024 cycle of the National Malaria Strategic Plan, with collaboration between an international Expert Group and a Technical Working Group, supported by Global Fund but the process owned by local government. She outlined the Malaria Policy processes from laboratory confirmation by microscopy or RDT and subsequent treatment with ACT's, integrated malaria case management, strengthening the malaria information system, prevention of transmission through IVM, as well as health promotion and community engagement. Dr Rita then outlined the three main steps for effective community engagement, under the headings of Advocate, Communicate, and Partnership. She then explained the roles of sectors and community in the prevention of malaria, spending time to explain each of the steps involved such as health education, networking, capacity building, strengthening information systems and several others. Moving on to Vector Control, Dr Kusriastuti indicated the need to strive for Universal Protection, mass coverage, and our current main tool for vector control is LLIN's for which we need community support, as well as for IRS in selected endemic areas and in some places and also larval source management, all of which require community support for optimal impact. She gave examples of Good Practice in community engagement, all contributing towards strengthening community support for malaria elimination and improved public health objectives.

Dr Jeevanie Harischandra (Senior Entomologist: Anti-Malaria Campaign, Sri Lanka) gave a presentation on "**Malaria Elimination: How Sri Lanka Achieved it and what it is doing to maintain it**". After thousands of years of being subjected to the unrelenting high levels of deaths and severe illness of malaria, the very real possibility of malaria elimination and even global eradication is now a reality, and many countries have indeed already eliminated this historic scourge. Sri Lanka is one such country, and it has valuable lessons to share of how it achieved that and what it does to avoid re-introduction. Dr Jeevanie started off with a slide on geography, physical features, climate and related data for Sri Lanka as context, then gave an overview of the malaria situation in Sri Lanka, that after centuries of endemicity the country very nearly reached elimination in 1963 but complacency resulted in a massive resurgence that took decades to get under control and finally reach full elimination of local transmission in 2012 and WHI malaria-free certification in 2016. However, the country remains highly receptive to potential re-introduction and has to maintain stringent measures to avoid such re-establishment of local transmission. She provided slides to show the range of malaria vector species in Sri Lanka, a graphic portrayal of annual case numbers since 1911 (with peak transmission recorded in 1934-1935 with between 5 and 6 million cases that season). She explained the strategies that were followed to achieve malaria elimination, and the strengths that enabled success, these being 1. Effective management of malaria foci, 2. Intersectoral collaboration, 3. Guidance and review, and 4. Availability of adequate funding. Dr Jeevanie then explained the multiple strategies, under 7 headings, that were deployed as part of the programme to ensure prevention of re-establishment of local transmission of malaria. She explained the classification of Divisional Areas based on risk of importation and receptivity in

Sri Lanka, as well as a decision-matrix as an aide for entomological surveillance & response in Sri Lanka. Dr Jeevanie outlined the process of entomological surveillance across the country, where they have 17 sentinel sites, and the process of malaria acse management and response, which is based on: 1. Case notification- Immediately by phone to RMO & AMC HQ (24 h); 2. Case Response- Treatment is begun within two hours of diagnosis; 3. Case investigation then takes place, by way of Primary parasitological surveillance (reactive case detection-started (within 24 hours) and Entomological surveillance- within 48 hours, followed by 4. Vector control if indicated - started within a week. Another slide depicted the different kinds of vector control responses depending on the nature of the case and local situation. Of great value also was the description by Dr Jeevanie of the bionomics and breeding sites of *Anopheles stephensi*, which invaded Sri Lanka and serves as an urban vector of malaria. She explained the Risk Groups for re-establishment, the Technical and Advisory Groups they have in Sri Lanka to contribute to prevention of Re-establishment, the Multisectoral Collaborations that exist, as well as the challenges that are associated with Prevention of Re-establishment, these being: 1. Financing (Cessation of funding from previous major funding sources (GFATM); Reduced national budgets due to country's economic crisis; 2. Human resources (Retirement of skilled workforce; Cases reporting in previously non endemic areas less human resources eg: Colombo, Galle, new RMO; appointed to NIHS; Frequent transfers of Medical Officers). 3. Other challenges (Presence of recently introduced *An. stephensi* in 2 districts in the Northern and eastern regions, although eliminated from 2 other districts; Reduced training/exposure opportunities).

Prof Leo Braack (Co-Chair, APMEN VCWG, and medical entomologist – Malaria Consortium) gave a presentation on "**A history of Malaria Vector Control since 1898**". Leo outlined the discovery of the malaria parasites in febrile patients by Laveran in 1880 and subsequently the development of malaria parasites in mosquitoes by Ronald Ross in 1897 and the role of Anopheles in transmission. Ever since then we have relied primarily on vector control to combat malaria. Initially, as far back as enabling the Panama Canal to be built despite severe challenges by malaria and yellow fever, this vector control took the form of larval source management by way of draining of ditches and swamps, use of Paris Green and oil in breeding pools, house screening and supplementary methods. During the 2nd World War Chloroquine (Resoquin) was re-discovered, and also the efficacy of DDT against louse-borne typhus, and together these two compounds formed the backbone of the WHO Global Malaria Eradication Programme, which was abandoned in 1969 due to the development of resistance. However, large parts of the world had been cleared of malaria during this period, including continental USA, parts of Europe, and many other places. Following the mid-century emphasis on IRS as primary vector control tool, the discovery of synthetic pyrethroids in the 1970's and adoption of ITN's led to a new era for coordinated global effort against malaria, with establishment of the Roll-Back Malaria partnership in 1998 and a renewed commitment to global eradication in 2007, with major support from the Bill & Melinda Gates Foundation. Mass distribution of LLIN's was emphasized (2.5 billion in the period 2004 – 2021), with major impact and reduction in malaria, but a clear plateau of impact around 2015, with increasing and expanding insecticide resistance causing sustained setbacks in progress in malaria reduction. Leo then explained the new generation of LLINs with dual active ingredients, and the promise of new products now in trial such as Attractive Targeted Sugar Baits, endectocides, greater adoption of larval source management as a supplementary method of vector reduction under appropriate circumstances, "building out" mosquitoes, ongoing trials on gene drive, topical and

space repellents, as well as integration of modern tools for support in vector control, such as drones.

Dr Iqbal Elyazar (Program Head of Geospatial Epidemiology, Oxford University Clinical Research Unit Indonesia) gave a presentation on "**Current Status of Malaria in Indonesia; Progress and Challenges in Elimination**". Dr Elyazar covered the following areas during his presentation: What is the elimination goal? How is the current progress? Where are the challenges? How to achieve the elimination? He reminded us that Indonesia comprises 274 million people living on 2300 islands, and that the country is 5300 km long (+/- from London to Kabul), with a Decentralized system: 34 provinces, 514 districts/cities. The country has regional targets for achieving overall malaria elimination, starting with Bali in 2023 and whole country by 2030. The country has a heterogeneous variety of endemicity, requiring a unique strategic approach for each region. The interventions go through various stages, ranging from Acceleration to Intensification to Elimination and finally Maintenance of transmission-free status, each stage having its own Objectives, Targets and Activities. He gave an outline of the levels of endemicity in each region, ranging from malaria-free to low, medium and high endemicity, defined by different levels of Annual Parasite Index, stating that only 1% of people live in high endemic areas and about 11% of people live in malaria endemic areas which comprise 142 districts. Dr Iqbal then showed slides depicting the annual case numbers and Annual Parasite Index across the country for the period 2010 to 2022, mentioning that in 2022, there was an increase of 64% in the case examination rate compared to 2021, which led to a 45% increase of case detected. While explaining a series of slides that looked at cases in different geographic areas, he mentioned that there is a declining rate of reported cases somewhat stagnant in the last several years, and that the real burden is likely higher than reported, but the gap is declining. The current effort is insufficient, need more aggressive approaches in surveillance. He also mentioned that cases are highly concentrated in the island of Papua, with most cases coming from Mimika and Jayapura in Papua. He clearly explained the various factors influencing transmission and intensity, and the vectors involved in the different geographic areas, their breeding sites, characteristics of mobile and migrant populations, these being 1. Local population - Live in a particular area more than 1 year, 2. Mobile population - Live in a particular area < 6 months, and 3. Migrant population - Live in a particular area between 6-12 months. He explained the contribution of different segments of society to malaria case numbers, including Miners, Forest Loggers, Travelers and others. Dr Iqbal gave recommendations on how to interact with Mobile and Migrant People to reduce malaria incidence, and also discussed Challenges and Mitigation for achieving malaria elimination. Then followed a detailed series of slides outlining steps and activities to achieve the general and specific objectives for malaria elimination, and discussion on Budget as well as Research and Innovation. An excellent presentation.

Dr Raman Velayudhan (Head: NTD's WHO Geneva) gave a presentation on "**Current Status of Dengue Globally, and specifically Asia and the Associated Challenges**". He opened with a slide to illustrate the global distribution of current or previous recorded transmission of dengue, chikungunya, zika or yellow fever, which revealed that most areas of the world had recorded three or more of these diseases. He explained that there is a silent expansion of the arbovirus vectors *Aedes aegypti* and *Aedes albopictus*, and that the number of countries that have recorded dengue exceed 130. These increases are largely associated with increased urbanization (with urban sprawl and unhygienic conditions offering *Aedes* breeding sites) and Climate Change expanding favourable conditions for these species. WHO is responding by

providing a series of guidance documents and the recent launch of the Global Arbovirus Initiative. He showed graphs depicting global cases and mortality for dengue, and the spread of dengue and chikungunya in Europe, as well as a graph that depicts the clear trend of increase in dengue in the America's from 2000 to 2022. He explained the recommended actions for addressing the rising threat of arboviruses, by a combination of (1) regional and country implementation of the Arbovirus.

Initiative to integrally address arboviral diseases (2) capacity building at regional level to embrace member states (3) improved data availability on arboviruses including Zika and chikungunya (4) capacity building for improved diagnostics (5) improved tools for surveillance (6) improved Case Management (7) more sustainable tools for vector control and prevention which include *Wolbachia* (population replacement), *Wolbachia* (population suppression), and Sterile Insect Technique, as well as use of spatial repellents. He then discussed the need for and benefits of integrated urban vector control against *Aedes aegypti* and *Aedes albopictus*, *Culex quinquefasciatus*, and *Anopheles stephensi.* As concluding points, Dr Velayudhan raised the following issues and discussed their relevance: (1) climate change and ways to mitigate its impact (2) climate refugees and movement of vectors (3) increased urbanization and possibility of large-scale outbreaks (4) lessons from COVID 19 (5) diagnosis (6) enhanced surveillance including burden estimation (7) effective communication methods (8) involvement of communities (9) the need to address gender, equity and human rights issues (10) to carry out burden estimation periodically for greater advocacy (11) foster multisectoral collaboration (12) shift to integrating surveillance activities (13) invest in research (14) including climate change's impact on the spread of diseases (15) promote effective communication and outreach strategies (16) vaccines and prevention and (17) a need for innovations in health systems and integration of programs.

Figure 2 Group photo of course participants, speakers and facilitators. They showed the V finger pose for 'vector control'.

Day 2: Tuesday, 4th July 2023

This day was devoted almost entirely to presentations by **Professor Neil Lobo**, from the University of Notre Dame in the USA, who developed the **Entomological Surveillance Planning Tool** for the University of California San Francisco Malaria Elimination program. The purpose of the training from Neil is to explain why one does vector surveillance and how it is done. Neil started off by outlining the importance of mosquito-borne disease, the reliance on vector control to combat malaria, and why it is so important to remove the older generation of female mosquitoes as they are the individuals that carry *Plasmodium* parasites. After ingesting a bloodmeal with gametocytes, it takes about 12 days for a mosquito to become infective to humans, by which stage the majority of adult female mosquitoes have already died and only a small proportion survive. With each passing day after that the adult mosquito population rapidly declines, but it is this fraction of females that pose a disproportionate threat of infection to humans; this is why vector control is so important as it assists in reducing the number of old females in the population. Dr Lobo explained the various mosquito feeding behaviours, and that effective vector control interventions will only target certain portions of the mosquito population, such as LLIN's and IRS that target indoor-biting and indoor-resting mosquitoes. Where there is not an overlap in mosquito behaviour and control intervention, there is a gap in control, so the better a vector control intervention targets vector behaviour, the more effective it is. Neil then moved on to explain the critical importance of vector surveillance as it underpins vector control…you cannot have effective vector control unless you do effective vector surveillance. Prof Lobo then moved on to introducing the UCSF *Entomological Surveillance Planning Tool* (ESPT), which has the following attributes:

1. It is a decision-support tool for planning entomological surveillance activities, interpreting entomological data, and guiding programmatic vector control decisions.
2. The ESPT aligns and distills WHO and PMI guidance.
3. Promotes a practical and cost-effective question-based approach to entomological surveillance, and 4. Supports the integration of entomological data with relevant metadata such as epidemiological, human behavioural, intervention, and climate data.

Figure 3 Prof Neil Lobo presented on Entomological Surveillance Planning Tool (ESPT)

The ESPT was developed as a joint initiative between UCSF MEI and the University of Notre Dame, in 2017, working closely with WHO, PMI and entomology experts from many other institutions and places. It has been piloted in 4 countries and is available in 5 languages. All language versions of the ESPT are available on the MEI website, at shrinkingthemalariamap.org.

He explained the Objectives of the ESPT as being 1. To support gap-filling in operational guidance for entomological surveillance, 2. To align with and operationalize WHO

and PMI global normative guidance, 3. To develop minimum essential entomological indicators to generate data that are actionable and collectible by national malaria programs, and 4. To deepen the integration of entomological, epidemiological surveillance and response. He further explained that the ESPT works on a question-based principle, it is a tool that responds and provides answers to the questions that you need to have answered to understand your vector population dynamics better and how to implement appropriate control interventions, and then to monitor the efficacy of those interventions. It also includes human behaviour aspects that impact on vector dynamics and control. The tool is highly flexible and can be designed to suit any program realities of budget and staffing constraints, providing options to guide and find solutions. He then provided an outline of the toolkit, as an algorithm that takes you step by step to ask appropriate questions that will enable finding appropriate answers for effective vector population understanding and optimal control interventions. In short, the toolkit provides 1. Guidance on how to translate your program's objectives into actionable program questions, 2. Guidance on selection of essential entomological indicators, 3. Appropriate sampling methods, 4. Appropriate sampling sites (sentinel, foci, targeted), 4. Sampling design. Prof Lobo spent time explaining Minimum Essential Indicators for a wide range of vector control interventions, including LLINs' IRS, LSM, ATSBs, topical repellents, endectocides and several more. This was followed by discussion of the sampling methods that are appropriate for finding answers for these Essential Indicators, sampling sites, sampling frequency, and decision trees for baseline surveys. Questions are basic and fundamental, such as "Will LLINs be an effective intervention in my site", with the appropriate list of information that must be gathered to answer the question. The ESPT is available online at http://www.shrinkingthemalariamap.org/tool/entomological-surveillance-planning-tool-espt or scan the QR code below.

Moving further with his day-long training, Prof Lobo explained the necessity of understanding how to identify and formulate programmatically relevant questions to inform the design and collection of entomological surveillance data, and how the ESPT can help to do this. There are six basic question themes to help think through the different types of program questions. These are:

1. Formulate your key question (e.g *Are LLINs effective in this area?*)
2. Identify the minimum essential Indicators that will answer your question
3. Identify the sampling methods that will collect the appropriate data to provide the essential indicators
4. Choose appropriate sampling sites
5. Decide on the sampling design that will yield the minimum essential data
6. Assess the available capacity and funding to determine how best to implement the sampling

He reminded everyone that for entomological data to be useful for malaria program decision-making, data collection should be (1) guided by a specific programmatically-relevant question (2) the question directly informs the entomological surveillance design and planning, including the selection of appropriate indicators, sampling methods, survey design, and sites, and (3) Identifying and formulating a priority program question is the first step in designing your entomological surveillance plan. Neil then provided a series of sample questions that serve as examples of the kinds of questions that underpin a surveillance program, these are just a few examples: (1) What is the baseline vector composition, distribution, and bionomics in an area where interventions are currently deployed? (2) How do current interventions affect vector populations and malaria epidemiology over time? (3) Are local vectors susceptible (or resistant) to insecticide-based interventions (e.g., ITNs, IRS)? (4) Is IRS effective in Area A based on vector behavior, human behavior, and insecticide susceptibility?

Prof Lobo moved on to a discussion on Essential Indicators, explaining how to use the ESPT to select minimum essential indicators to address priority program questions, to understand the role of human behaviour observations in identifying and targeting drivers of malaria transmission and gaps in protection, as well as understanding the importance of integrating and analyzing entomological, epidemiological and other relevant data for program decision-making. In this module of his presentation, he focused on the entomological, human behavioral, and intervention evaluation indicators for malaria programs. He explained the key concepts of Residual Transmission, Human Behaviour Observations, and Minimum Essential Indicators. Indicators provide evidence for the status or level of Vector species (species composition), Larval habitats, Receptivity, Seasonality (of transmission), Endophagy versus exophagy, Biting location, Biting time, Indoor resting density, Frequency of insecticide resistance,

Bioefficacy (of interventions), Intervention coverage, and Intervention usage (ITN/LLINs only). He discussed each of these indicators, explaining the importance of each. He reminded us that to select the most appropriate indicators to answer priority program questions, it is important to understand how vector control interventions target different vector behaviors.

Prof Lobo continued the training by moving to a module on selecting sampling methods and analytical techniques. It is important to understand the basic inherent advantages, limitations, and biases of each entomological sampling method and analysis technique, and also to understand how to use the ESPT to guide selection of appropriate and available sampling method(s) to address priority program question(s), accounting for method limitation and biases. He then explained the use of, and benefits and disadvantages, of each of the following sampling techniques: Human landing Catch (HLC), Human Baited Traps (HBT), Indoor Resting Collections, CDC Light traps (CDC-LT), Human Odor baited Traps (HOBT), Animal Odor Baited traps (AOBT), Outdoor Resting Collections, CO2 Baited trap, Gravid Traps, Window Exit trap (WET), and Larval Surveys.

In the next Module, Neil continued by discussing Site Selection and Survey Type. He explained the differences between different kinds of sampling sites, as follows: **Sentinel site**: fixed sites that are part of a network of sites that represent different ecological and epidemiological regions of a country. Entomological surveillance based at sentinel sites is important for measuring trends over time. **Focus site**: a defined area situated in a current or former malarious area that contains the epidemiological and ecological factors necessary for malaria transmission. Entomological surveillance in foci is important for informing the most effective response to reduce and interrupt transmission. **Targeted site**: a site targeted for a

spot survey to answer a specific question or set of questions. A targeted site could include an area experiencing an outbreak or an increase in importation risk or receptivity. Then he outlined the different kinds of survey types, as follows: **Baseline survey**: surveys to help characterize transmission, inform intervention selection and deployment, inform foci response, and evaluate existing interventions. **Routine survey**: surveys to monitor changes in vector populations over time, monitor the impact of interventions on local vectors, and identify emerging gaps in protection. **Focus survey**: surveys to gather priority epidemiological, entomological, environmental, and intervention data to inform response to halt onward transmission. **Spot survey**: time-bound surveys that target a specific area(s) with one or several questions in mind. He discussed each of these aspects in detail and explained the merits and limitations of each.

The next Module focused on sample design for operational purposes. Here the emphasis was on how to use the ESPT to develop a sampling plan based on priority program questions and available capacity and resources, and the importance of data standardization and data quality in the context of available capacity and resources. He explained the following parameters: **Sampling site**: the collection locality from where mosquito samples are collected to obtain relevant data to measure the indicators selected. **Sampling unit**: an individual unit for mosquito collection within sampling sites. E.g., a village, a house, a water body, etc. **Sample size**: the number of sampling units allocated (i.e., 'sampled') within a sampling site. The steps for sampling design were *Step 1*. Determine the sampling site, *Step 2*. Determine the sampling unit, *Step 3*. Allocate the sampling units, *Step 4*. Determine the sampling method, *Step 5*. Set the frequency of sampling. He explained each of these in detail.
Prof Lobo moved on to Module 6 of the ESPT, which is a short module with basic step-by-step guidance on how to prepare for and manage entomological data collection. It was divided into two sections: Steps to prepare for entomological data collection, and Data management including data entry, cleaning, and storage. Module 6 described one field example and one lab example to illustrate the basic steps of entomological data collection. Among the points he made was that data collected in the field or lab (on paper or digital data entry tools) must be digitized in a database, and that during this process, data cleaning and quality checking is key to identify data errors and empty cells and to ensure that formatting is standardized across data entries.

Prof Lobo then went through three Modules, all dealing with Decision Trees for different purposes, as follows: Module 7: Decision trees by indicator and for baseline surveys. Module 8: Decision trees for routine surveys and monitoring receptivity. Module 9: Decision trees for focus investigation. He explained that a Decision Tree is a support tool that uses a flowchart structure to visually guide you through several options or courses of action. Decision trees help to visualize and validate the decision-making process. He described each of these in detail.

Prof Lobo next described Gaps in Protection, which are essentially describe a circumstance when an individual and/or household is potentially exposed to malaria infection (i.e. an infective mosquito bite) due to a lack of effective and/or adequate protective or preventive intervention in place to reduce that exposure to mosquito bites. Gaps in protection can be directly identified through an assessment of how interventions interact with local human and vector behaviors. Drivers of transmission can also contribute to gaps in protection (e.g. rainfall, antimalarial stockouts). For the current core vector control interventions (LLINs and IRS), gaps

in protection can include insecticide resistance (reducing the effectiveness of the protection that the insecticide in LLINs and IRS provides) and occasions when people are outdoors without protection against potentially infective mosquito bites. He described several examples.

Prof Lobo concluded his day of presentations by describing a case study in Panama where the Entomological Surveillance Planning Tool was successfully deployed. Participants thoroughly enjoyed the presentations by Prof Lobo, and benefitted from the clear lecturing style and vivid examples and well-presented graphics. It was indeed an excellent set of training.

Professor Sylvie Manguin gave a very comprehensive presentation on the "**Malaria Vectors and Species Complexes in Asia Pacific: Composition, Distribution and Bionomics of the Dominant Vector Species**". She started her presentation with some slides as a reminder of the global malaria situation in 2021, as reported in the WHO World Malaria Report 2022. She reminded us that an estimated 247 million cases of malaria and 619,000 malaria deaths in that year represented an INCREASE in malaria, thus a serious reminder of the challenges associated with reducing the malaria burden. She narrowed down to the situation in Southeast Asia, describing the high level of vector diversity and the added challenge of *Plasmodium knowlesi*. China is the most recent success in Asia for eliminating malaria, with the very effective implementation of the 1-3-7 strategy for case reporting, epidemiological investigation, and control response. Sri Lanka also had valuable lessons to share. She explained the necessity for all stakeholder engagement, from local communities to national government. She explained the six core principles for achieving malaria elimination in Asia, these being (1) Cross-border and regional collaboration to optimize malaria responses at the international borders (2) Improve the knowledge on malaria vector species for efficient vector control programs (3) Tailored responses based on a mix of interventions and strategies adapted to local conditions (4) Strengthened focus on surveillance to eliminate any remaining areas of transmission (5) Reinforced access to health services for malaria prevention, diagnosis, treatment and vector control of poor and remote populations, and (6) Development of innovative malaria control tools. Sylvie then explained the high number of malaria vectors in Asia that belong to Species Complexes and Groups, and the need to use molecular techniques to resolve species differences when morphological identification was not possible. Sylvie then showed the geographic distribution of the dominant malaria vector species in Asia-Pacific, in addition also explaining biting behaviour, breeding sites and other habitat associations of each of the various species, and explaining the key PCR agarose gel banding differences between member species of the various complexes and groups. She ended off by giving examples of misidentification of species because malaria control programmes had relied on morphological identifications instead of PCR confirmations, resulting in expensive and ineffective control interventions based on wrong assumptions of vector species involved. Species distribution and abundance do not remain statis in a particular area, but can dramatically change due to evolutionary pressures from insecticide nets and sprays. Correct mosquito identification allows (1) Estimation of the correct entomological inoculation rate (EIR) and pathogen transmission (2) Reliable analysis of vector behavior (trophic, biting pattern, seasonality) (3) Correct resistance/susceptibility level to insecticides, (4) a correct understanding of the bionomics of the vector species (distribution, ecology).

Day 3. Wednesday, July 5th 2023

Mr Mujiyono gave a presentation on **Mosquito Morphology and Systematics** and briefly explained the parts of mosquito body including head, thorax, wings, gut, and legs. He also described the difference between *Aedes*, *Culex*, and *Anopheles* eggs. In addition, he explained the venation of the wings of mosquitoes that are used for identifications. He also gave a presentation on the **Use of Dichotomous Keys.**

Triwibowo Ambar Garjito, Ph.D. gave the lecture on **Mosquitoes Morphology (Genera: *Aedes, Anopheles, Culex, Mansonia, and Armigeres*): Adults and Larva** using the Walter Reed Biosystematics Unit (WRBU) website. He described in detail how to differentiate the larvae from different genus. Twenty-two microscopes were prepared so that all participants could practice identifying the mosquito genus (*Aedes, Anopheles, Culex*, *Mansonia* and *Armigeres*).

Dr Tanya Russell gave an overview of **Dengue vector identification: *Aedes aegypti* and *Aedes albopictus*: Adults, pupae, larvae (theory)** and Dr Triwibowo then continued with the laboratory session for both dengue vector identification.

Figure 4 Participants was having the mosquito morphology practice session with stereomicroscope

Day 4: Thursday 6th July 2023

Figure 5 Participants set human-baited double net trap nearby rice field.

Course participants vacated their hotel rooms, stored un-needed personal belongings in a storage area provided by the hotel, and checked out of the hotel. In three mini-van vehicles we drove roughly 2.5 hours to the small city of Magelang where our baggage was deposited, and then immediately drove on to our field station at the sub-village of Komboran (village of Paripurno). Komboran is a small village. Here we met staff of the Institute for Disease Vector

and Reservoir Control Research and Development (IVRCRD), and we unpacked the various items of equipment needed for the mosquito collections later that day. Once unpacked, we set about erecting or placing a series of different mosquito collection traps, including three CDC light traps (baited with dry ice for carbon dioxide attractant) in three different vegetation and habitat types, a human double-net trap in a rice-field, an animal-baited net trap (with a water-buffalo as attractant), and three different locations for Human Landing Catches of mosquitoes. After an early dinner the participants – previously split into three equi-sized groups – moved to their respective collection stations. Each group had opportunity to spend 45 minutes doing Human Landing Catches (followed by 15 minutes of mosquito catch processing), serving as bait in the human double-net trap, and doing mosquito collections at the animal-baited net. The weather was unfortunately not very conducive to strong mosquito activity, due to a frequent slight breeze and later at night some light drizzle of rain. After three such rotating rounds of collections, at 10pm we drove back to the hotel in Magelang for much-appreciated sleep.

Figure 6 (Left) Timor-Leste participants adjusted the height of CDC light trap and its dry ice, (Right) mosquito collection was done during night time for the human-baited double net trap

Day 5: Friday 7th July 2023, Field sampling and Sample Processing

Participants rose early and travelled by minibus to the field basecamp at Komboran, Paripurno Village, Salaman District, Magelang Regency, before sunrise as mosquitoes attempt to escape from nets once the sun rises. Participants collected mosquitoes that had been attracted to the dry ice bait in a net-trap overnight, and also from the animal (buffalo)-baited net trap, then the collections from the CDC light traps, and outdoor resting mosquitoes collections on soil slopes and plant roots. This was followed by a demonstration of an indoor knockdown spray catches in a domestic home, and use a Prokopack suction device for indoor resting mosquitoes. All mosquitoes obtained were put into paper cups and were labeled depending on the collection method, date and time, and the team code.

After all the participants had breakfast at the base camp, then reused their boots and brought deeper, plastic pipettes and trays to look for mosquito larvae in a river with a topography of lots of rocks and running water, beside rice fields and on the other side coconut plantations belonging to the local community and several genera of mosquito larvae were found there, not forgetting to label the larvae bottles.

All participants packed tools and equipment to find larvae and mosquitoes, then returned to the Artos hotel to carry out the next process. For those who are Muslim, perform Friday prayers in the space provided by the hotel.

After lunch, the participants continued their activities in the hotel room which was set up to be a laboratory with lots of microscopes. Using mosquitoes and larvae collected in the morning

and evening before, sample processing is carried out, data is recorded by noting it on the form provided, then practice mosquito pinning (separated between Anopheles and other genera), using minutten pins or size 3 insect needles, then learn to store and transport mosquito samples using silica-gel and tubes, and other storage techniques for mosquitoes and larvae.

Figure 7 (upper left) Course facilitator performed Anopheles *collection using mosquito aspirator in vertical soil and vegetation root crevices as one of resting places for malaria vector in Indonesia. (Upper right) Resting malaria vector collection in bushes. (Bottom left)* Anopheles *larval collection in slow flow river in Magelang District. (Bottom right) Participant was preparing pinning mosquitoes as part of Mosquito Sample Processing topic.*

Day 6: Saturday 8th July 2023, Vacation around Magelang and Return to Host Institution

The field equipment was packed up and stowed away by IVRCRD staff in the vehicles for transport back to Salatiga, and the participants joined their respective three minivans for the drive back to Salatiga where the course would continue from Monday. Making use of being in the vicinity, a big highlight was a visit to the ancient Buddhist temple of Borobudur, the biggest Buddhist temple in the world and built during the 9th century. Then on to Salatiga along a beautiful drive through mountainous regions and mist-shrouded towns, until we checked in again at the Grand Wahid Hotel. Everyone agreed the field trip was highly instructive and that the discussions of trapping techniques and practical experience were very helpful.

The location for catching mosquitoes is in the district of Magelang and close to the Borobudur temple, the largest temple in the world, therefore all participants take a tour there which is only 15 minutes from the hotel. The participants were very happy, they took pictures and shop for souvenirs, be it key chains, wall hangings, clothes, t-shirts, hats and others. In addition, participants also enjoyed local specialties foods around the temple.

Participants return to Salatiga via the Ketep pass, because the view is good between Mount Merbabu and Mount Merapi (one of the most active volcanoes in the world), so the participants

take a short break there, and a very suitable combination while drinking hot coffee with cold air.

Day 7: Sunday 9th July 2023, Rest and recreation

Course participants used the time to relax and go into the city for shopping or sightseeing activities in traditional markets.

Day 8: Monday 10th July 2023, Mosquito Morphology: Microscope introduction to mosquito genera – ADULTS: Anopheles, Aedes, Culex, Mansonia, Coquillettidia, Armigeres

Mr Triwibowo and Mujiyono gave a lecture of taxonomic and ecological knowledge regarding mosquito genera *Anopheles, Aedes, Culex, Mansonia, Coquillettidia, Armigeres* 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 IVRCRD Salatiga Indonesia insectary, using microscopic and other tools as well as dichotomous keys for mosquito species of the Region.

Figure 8 Participants identified Anopheles *specimens that were provided by the facilitators.*

Day 9: Tuesday, 11 July 2023, Mosquito Identification Using Bench Aids and Pictorial Keys

Activities on the ninth day were held at IVRCRD. The activity was to continue identifying mosquitoes using a microscopic identification key, after on the eighth day it had been explained how to identify mosquitoes using several identification keys, which included identification keys Bonne-Wepster Australasian Anopheline, and others. In the morning the participants were asked to independently identify the mosquitoes that had been provided by the IVRCRD team. This identification activity was guided and assisted by the facilitators. Mosquitoes provided for identification include mosquitoes of the genus *Anopheles* in western and eastern Indonesia and Papua New Guinea, including: *An. barbirostris, An. farauti* and *An. maculatus*. The participants are welcome to choose for themselves which identification key to use, and the participants can also compare between identification keys.

During the day, apart from self-identification, mosquito identification activities are also carried out together with the guidance of Mr. Mujiyono. He used a dissecting microscope that had a camera attached, and then identified mosquitoes together with the participants. Apart from being guided by Mr. Mujiyono, the participants were also welcome to discuss with each other about the identified mosquitoes together. Mr. Mujiyono also provided a quick way to identify

mosquitoes, as well as telling the participants about the characteristics of each mosquito that is often found in the field.

The ninth day's activities went smoothly, and the mosquito identification activities will continue on the tenth day. At 5 pm the participants are welcome to return to the hotel to take some rest.

Day 10: Wednesday, 12 July 2023

The morning was spent with microscopic familiarization with *Aedes, Culex, Mansonia, Armigeres*, and *Toxorhynchites* mosquitoes, and also larval *Anopheles* morphology, and a test of the familiarity which each member of the group had developed in using the dichotomous keys. During discussion it became clear that all participants had thoroughly enjoyed the preceding two days of dichotomous key identification of mosquitoes, that it was valuable experience for them, and that they felt they had received excellent training from Mr Mujiyono.

After lunch we had a presentation by **Dr Rajpal Yadav** on **Insecticide Resistance Testing in Mosquito and Sandfly Vectors.** Dr Yadav started off by explaining the context of the WHO TDR Global Vector Control Response 2017-2030 and the four Pillars of Action on which it based. He then moved on he explained the WHO Bioassay methods (WHO Tube Tests for adult mosquitoes, WHO Bottle Bioassays for adult mosquitoes, and larval tests) as well as Molecular and Biochemical assays for detection of resistance mechanisms. He described the WHO Tube Test and the steps of Pre-exposure holding of mosquitoes in tubes lined with clean white paper for one hour, then exposure for one hour in tubes lined with insecticide-impregnated paper (red-dot tubes) and control tubes (yellow-dot tubes) with paper impregnated either with oil or acetone alone, finally transferring the mosquitoes to holding tubes for 24 hours but with access to sugar-water cotton wool, after which the mortality is recorded in each tube. He explained the relatively recent addition of the WHO Bottle assay, and that the WHO Tube and WHO Bottle assays are not simply alternatives to use, but the choice is based on the type of insecticide being used as some insecticides are compounds which can easily be impregnated into filter paper as with the WHO Tube assay, while others have to be dissolved in silicone oil or acetone for use as bottle assays…the two are not interchangeable. The bottle bioassay is for compounds that cannot be impregnated on filter paper, and include transfluthrin, prallethrin, metofluthrin, clothianidin, flupyradifurone, chlorfenapyr, and pyriproxyfen. The WHO Bottle bioassay is similar to the CDC bottle assay but with endpoints aligned with those of WHO tube tests. For the WHO Bottle assay and the WHO Tube Test, he mentioned that the shelf-life of Pyrethroid-impregnated papers has been extended to two years, after tests have shown that the efficacy of the insecticide does not significantly degrade over that period. The Cut-off points for insecticide susceptibility assays is >98% mortality after 24 hours (in which case population is fully susceptible to the insecticide being tested), 90-97% mortality (means there is a possibility of resistance), and <90% mortality (means there is definite resistance in the population). New Discriminating Concentrations for a wide range of insecticides have also been developed for *Aedes* mosquitoes as a WHO Tube assay, and also for *Culex quinquefasciatus* and *Culex tarsalis* mosquitoes, as also for sandfly vectors of Leishmaniasis. Dr Rajpal explained the Standard Operating Procedures for testing susceptibility; this can be downloaded from https://www.who.int/teams/control-of-neglected-tropical-diseases/interventions/strategies/vector- control/insecticide-resistance. Highly helpful, Dr Rajpal also explained about automated spread sheets for preparing stock solutions and about procurement of test kits and impregnated papers, as well as storage and use of

impregnated papers and data management. Finally, Dr Yadav spoke about using insecticide resistance data for programmatic decisions and resistance monitoring considerations.

Figure 9 Course participants and facilitators demonstrated WHO tube for insecticide susceptibility test and cone bioassay.

Day 11: Lecture on Methods and basic infrastructure for mosquito colony establishment and maintenance in IVRCRD insectary.

Presentation by: Riyani Setiyanngsih, S.Si, M.Sc

The morning was devoted to familiarizing the group with the establishment and maintenance of an Insectary. An excellent presentation was given by Ms Riyani Setiyaningsih, who explained the processes involved in running the insectaries at IVRCRD. In their Insectaries they maintain colonies of *Toxorhynchites*, *Anopheles*, *Culex* and *Aedes*. The *Toxorhynchites* adults are not blood-feeders and instead are fed on honey and apples, while the predaceous larvae are fed on larvae of other mosquito species. They also have colonies of *Anopheles aconitus*, *An. maculatus*, and *An. sinensis*. The *Anopheles* populations are kept in rooms at a constant temperature of 25-30 degrees centigrade, humidity of 80-90%, and the larval food comprises of a powdered mix of dog biscuit, yeast and beef, in a ratio of 10:3:1. The insectaries at IVRCRD usually maintain a productivity rate of daily pupal production of *An. maculatus*: 1500/day, *An. aconitus*: 450/day and *An. sinensis*: 70/day. Live guinea pigs are used to provide blood-meals twice per week for the females, and this is supplemented with cotton wool soaked in 10% sugar water. Eggs are placed in a tray lined with filter paper. The eggs hatch 2-3 days after being laid, and the larvae are transferred to trays at a density of 400/tray. They also breed *Aedes aegypti* and *Aedes albopictus*, and *Culex quinquefasciatus*. Riyani explained in detail the various processes involved in maintaining the different stages of the mosquito life cycle and optimum population health.

After discussing with Ms Riyani, all participants were divided into two Groups. The first group conducted Force Mating for mosquitoes, and the second group practices on rear mosquitoes (separating pupae and feeding *Anopheles* with guinea pig).

Figure 10 (upper left) Ms Riyani was explained in detail the various processes involved in maintaining the different stages of the mosquito life cycle and optimum population health. (Upper right) Participants practiced separating pupae and putting it into the mosquito cage. (Bottom left and right) Preparing guinea pig for feeding the mosquitoes.

Lecture on Susceptibility test using CDC Bottle Bioassay

The rest of the day was spent in demonstrations of the CDC Bottle Bioasaay Test for insecticide susceptibility monitoring facilitated by Ms Ary Oktsariyanti, with participants having ample opportunity for hands-on practice in the use of these assays (bottle coating, mosquito transfer to the bottle and so on).

Thursday evening the group enjoyed the wonderful Course Gala Dinner, organized by IPDCA and IVRCRD and held in the outdoor pool-side area at the Grand Wahid Hotel. There was a professional Master-of-Ceremonies, singer and an excellent dinner, accompanied by short speeches and awards and gifts being handed out, spontaneous dancing, much laughter and collective singing and a widely-held opinion that this was one of the most enjoyable evenings had by all in a very long time. It was a wonderful opportunity to cement friendships and contacts.


Figure 11 Gala Dinner for group of participants and facilitators

Day 12: Anopheles Molecular Analyses (introduction).

Presentation by Mr. Boni Sebayang

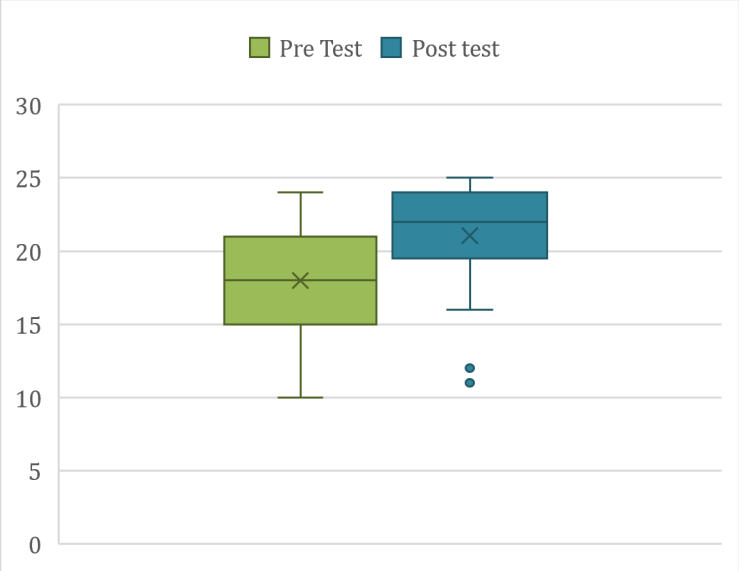
The morning was devoted to familiarization with molecular biological techniques used for PCR identification of adult *Anopheles* and PCR/ELISA identification for *Plasmodium* sporozoites. We had an excellent foundational lecture by **Mr Boni Sebayang** (MMedSc, James Cook University), who took time to provide a thorough and clear explanation of the reasons and practices involved in PCR assays. First, he explained the DNA extraction process, indicating that assays can target different DNA, specifically Ribosomal: ITS2 gene, and Mitochondrial: COX1/COI. For molecular taxonomy targeting ITS2 gene, Molecular taxonomy: ITS2 gene, it is useful to follow the process as described by Beebe and Saul (1995), while for the COI gene the procedure described by Folmer et al., 1994 is advised. He outlines the methods for detection and surveillance of malaria pathogens, using Quantitative PCR (qPCR), Nested PCR, and Circumsporozoite protein enzyme-linked immunosorbent assays (CSP–ELISAs). After spending quite some time describing the above techniques, he moved on to PCR identification of host blood-meals in mosquitoes, indicating that host origin can be detected in female mosquitoes up to 72 hours post-feeding. He explained the PCR procedure. Then he moved on to PCT detection of Insecticide Resistance mechanisms. After the lecture the participants were split into groups, rotating through demonstrations of the equipment and processes in different laboratories at the Institute - very impressive.
Participants also visited the IVRCRD specimen's museum for educational purposes with various mosquitoes, rats, and bats specimens, and the Covid-19 Museum.

The Post-course questionnaires were administered to assess the level of improvement of trainees over the period of the course (the knowledge average moved up from 76% at the start of the course to 84), and the 4th MVSE course was concluded before breaking for lunch, and departure of several of the group members for their return trip home.

Course Evaluation

Knowledge assessment

Twenty-five questions were administered to the training participants on Day 1 of the training as a pre-test. The questionnaire covered the topics in the training course and was used to assess the baseline knowledge of participants. The same set of questions was administered on the last day of the training to assess the knowledge change after training. At baseline, the average pre-test score was 18/25 and the maximum score was 24/25. For the post-test, the score improved very well as the average score increased to 21/25 with the highest score of 25/25.



Skill assessment

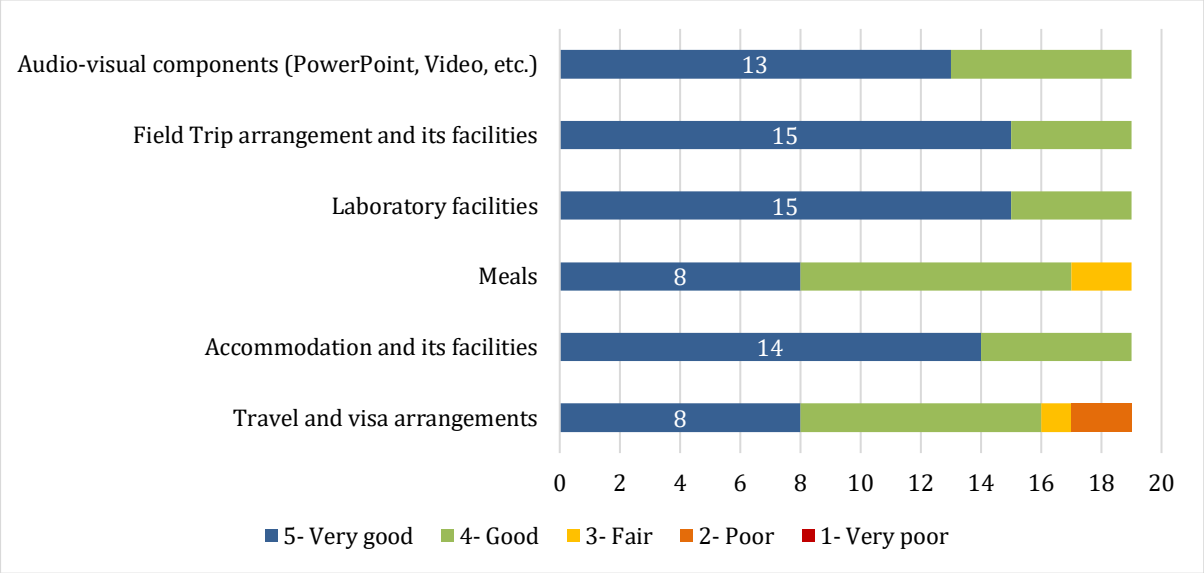
In addition to knowledge assessment, we also evaluated the mosquito morphological identification skills of participants. The pre-test for mosquito identification was administered on Day 8 to all participants and the post-test was done on Day 11. Mr Mujiyono and his team prepared 10 specimens of adult mosquitoes from the genus *Aedes, Culex,* and *Anopheles*. Eight mosquito specimens consisted of malaria main vectors from Indonesia, Malaysia and Papua New Guinea. The participants were given 10 minutes to identify the mosquitoes by using the dichotomous key. The assessment was supervised and evaluated by Mr Mujiyono. There was no passing mark that was set for this quick assessment but to compare the average score gained by the training participants. More than 50% of participants got ≥5 correct identification during pre-test, but during post-test the percentage declined to 41%. Most of participants mentioned that there was more pressure and nervousness to get correct identification especially after they got exposed and learned on mosquito identification topic. The mosquito identification process should have been given more time to provide accuracy in identification.

Participant feedback

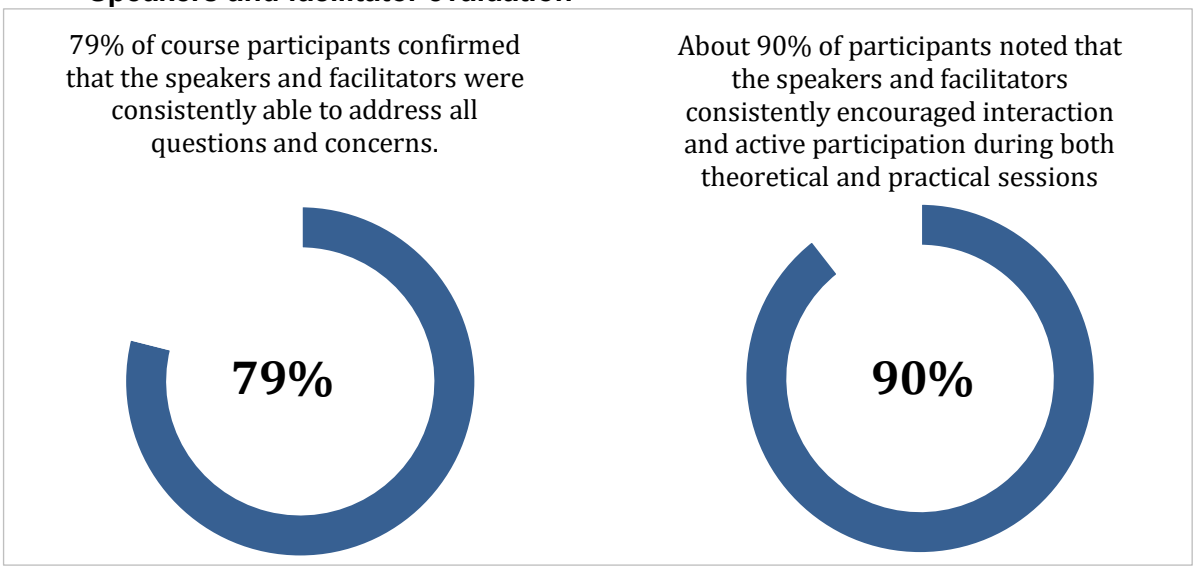
- **Course logistics**

A 5-point Likert scale evaluated how participants felt about the 2-week training. Additional qualitative information was requested to allow participants to provide their opinion and suggestions for the training. The survey was conducted on the last day of the 4th MVSE Course. In terms of logistics, the majority of class cohort were satisfied with the logistics arrangement of the course, that were provided by the IVRCRD and IPDCA team. While

participants approved the overall logistics arrangements, there are some areas need to be improved, particularly for travel arrangements and meals.



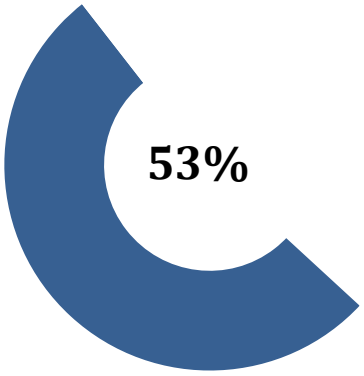
- **Speakers and facilitator evaluation**



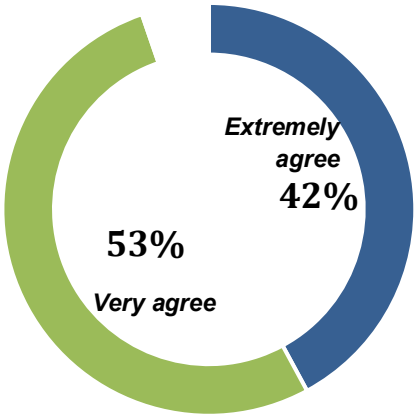
- **Course benefit**

The training participants were asked to rate the 4th MVSE course benefit to their job as entomologists or vector control staff in their respective National Malaria Programme. The overwhelming majority of the training participants indicated that the 2-week course enhanced understanding and ability to their routine tasks in the malaria programme. The course participants were better equipped to do the vector surveillance activities more effectively.

53% of participants reported that the course significantly improved their understanding and enhanced their ability to perform their roles as vector control officers within their respective National Malaria Programs.

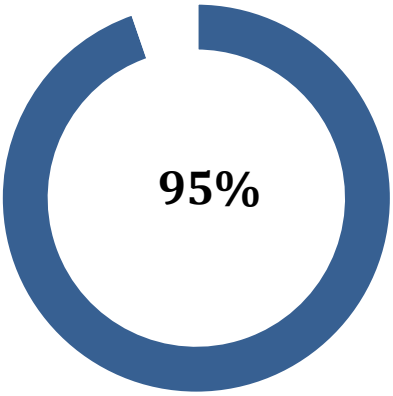


When asked about the course's impact on their role as field entomologists in the fight against malaria, most participants expressed high levels of agreement, with 42% stating they "extremely agree" and 53% indicating they "very agree."



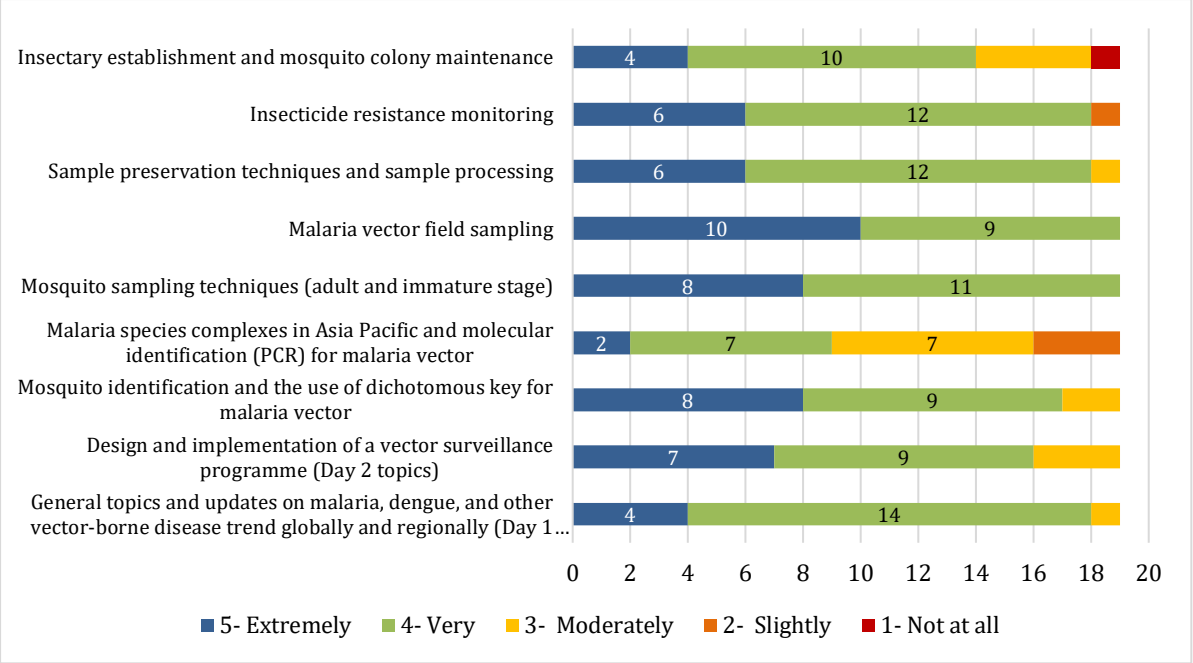
- **4th MVSE met the participants' expectations**

The majority of participants either "strongly agreed" or "agreed" that the 4th MVSE Course fully met their expectations.



- **Rating of the course modules applicability**

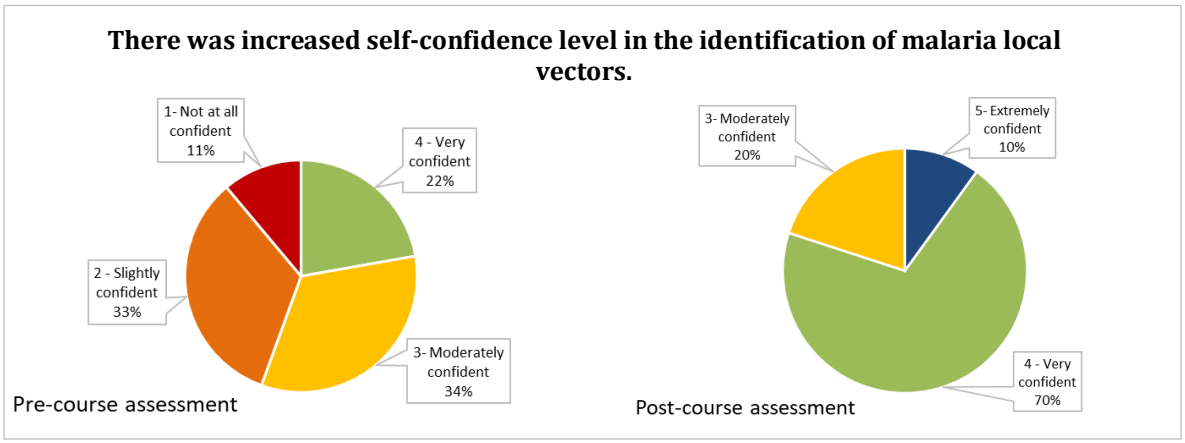
Apart from the general applicability of the course for participants, they were asked to rate the course modules and topics in relation to their routine tasks. Notably, the malaria species complexes, and molecular identification (PCR) topics were relatively 'very applicable' and 'moderately applicable' for the training participants. This might be because most of them were field entomologists and vector control staff, and the molecular identification can only be done in some molecular reference laboratory.



- **Learning outcomes evaluation**

Pre- and post-course self-efficacy was measured to understand the level of individual readiness and confidence to apply the knowledge and skills acquired by each participant when they return to their workplace. We administered the questionnaire on the first day and last day of the training and will send participants the questionnaire in January 2024 to assess the learning outcomes 6 months after the course. The questions evaluate participants' learning outcomes on seven different skills and knowledge for entomologists:

1. Design and implement vector surveillance programme and its M&E.
2. Mosquito identification of local species of main malaria vector.
3. Mosquito sampling techniques in the field for different purposes.
4. Mosquito sample preservation and sample processing techniques.
5. Apply insecticide resistance monitoring with available assays.
6. Apply knowledge on insectary establishment and mosquito colony maintenance.
7. Utilize molecular approach for species complexes identification.



Consideration for the 5th MVSE Course

Suggestions to improve the contents for MVSE course has been started since the 2019 course, and consideration for the next course is made from the previous course. There were no specific suggestions for the content of the 5th MVSE course based on the 4th MVSE evaluation and feedback. It would be great to maintain the good quality of deliverables in 4th MVSE to the 5th MVSE, such as:

- Good quality and enough quantity of stereomicroscope for at least 25 participants
- Enough mosquito samples for participants in the mosquito identification hands-on practice.
- Enough time to assess participants' skills in mosquito identification.
- Contents and mosquito species provided are focused and based on the regionality or participating countries.
- Adequate space and equipment for insecticide susceptibility tests.
- Molecular identification for species complexes would be better to have longer duration (half day) with hands-on practice for each participant. Based on this suggestion from participants, APMEN VCWG will hold an in-person training on 'PCR technique for mosquito identification' in 2024 to accommodate the needs from the Asia Pacific entomologists to the molecular approach to identify malaria species complex in the region.

ANNEXURES

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Annexure 1: Course Programme

PROGRAMME
4th INTERNATIONAL MALARIA VECTOR SURVEILLANCE FOR ELIMINATION COURSE

Indonesia, 3 – 14 July 2023

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
Sunday 2 July 2023	**14.00 WIB (start check in)**	Arrival host city and accommodation check in		**Grand Wahid Hotel Salatiga and IVRCRD team**
		No formal work activities		
Day 1: Course Opening Master of ceremony: MoH/IVRCRD				
Monday 3 July 2023 (Day 1)	06:30 – 08:00	**Breakfast**		**Grand Wahid Hotel Salatiga**
	08:00 – 08:30	Registration and administration	IVRCRD	
	08:30 – 08:40	Welcome and opening speech on behalf of Host Institution	BKPK	IVRCRD and BKPK
	08:40 – 08:50	Welcome on behalf of Regional Malaria Control Programme	Dr Ferdinand J Laihad	IVRCRD
	08:50 – 09:00	Welcome by Hosting Institution	Acting Director of IVRCRD	
	09:00 – 09:10	Welcome on behalf of APMEN, and outline of course	Prof. Leo Braack, APMEN Vector Control Working Group and Malaria Consortium	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
Monday 3 July 2023 (Day 1)	09:10 – 09:15	Welcome on behalf of Partner Institution	Directorate of Disease Prevention and Control (Direktur P2PM)	Online
	09:15 – 09:30	Group Photograph	Photographer	
	09:30 – 09:50	Pre-course baseline knowledge evaluation (questionnaire-based)	Leo Braack	
	09:50 – 10:30	**Tea Break**		**Grand Wahid Hotel Salatiga**
	Module 1. Background and Context			
	10:30 – 11:15	Epidemiology of Malaria, Globally and Asia Pacific	Dr. Siswanto, MHP, DTM	Moderator: Triwibowo Ambar Gardjito, S.Si,M.Sc, Ph.D.
	11:15 – 12:00	Current status of Lymphatic filariasis, Japanese Encephalitis, and Chikungunya in Asia (Online)	Dr. K Krishnamoorthy, Regional Consultant for Lymphatic Filariasis WHO SEARO	Moderator: Prof Leo Braack
	12:00 – 12:45 [7am Geneva]	The importance of effective community engagement for entomologists	Dr. Rita Kusriastuti, IPDCA	Moderator: Wulan
	12:45 – 14:00	**Lunch**		**Grand Wahid Hotel Salatiga**
	14:00 – 14:45	Malaria Elimination: How Sri Lanka achieved it and what it is doing to maintain it. (Online)	Dr Jeevanie Harishchandra, Anti-	Moderator: Leo Braack (online)

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
			Malaria Campaign Sri Lanka	
	14:45 – 15:30	A history of Malaria Vector Control since 1898	Prof Leo Braack	Moderator: Shobiechah Aldillah Wulandhari S.K.M., M.Sc
	15:30 – 16:00	**Tea Break**		**Grand Wahid Hotel Salatiga**
	16:00 – 16:45	Current status of malaria in Indonesia, Progress and Challenges in Elimination.	Dr. Iqbal Elyazar (BRIN-Eijkman Institute)	Moderator: Triwibowo Ambar Gardjito, S.Si,M.Sc, PhD (online)
	16:45 – 17:30	Current status of dengue globally, also Asia regionally and main challenges (online)	Dr Raman Velayudhan, WHO Geneva)	Moderator: Leo Braack (online)
	17:30 – 17:40	Group discussion: Recap and review of key lessons of the day	Prof Leo Braack	
	18:00 – 20:00	**Dinner**		**Grand Wahid Hotel Salatiga**
	Module 2. Developing a Surveillance Programme			
Tuesday 4 July 2023 (Day 2)	08:00 – 08:10	Recap and participant comments on the previous day		Moderator: Prof Leo Braack
	08:10 – 09:30	Introduction to Vector Surveillance Approaches	Prof Neil Lobo, University of Notre Dame, US	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
	09:30 – 10:00	Design and Implementation of a vector surveillance programme	Prof Neil Lobo	
	10:00 – 10:30	**Tea Break**		**Grand Wahid Hotel Salatiga**
	10:30 – 12:30	Design and Implementation of a vector surveillance programme (*continued*…)	Prof Neil Lobo	
	12:30 – 14:00	**Lunch**		**Grand Wahid Hotel Salatiga**
	14:00 – 15:30	Design and Implementation of a vector surveillance programme (*continued*…)	Prof Neil Lobo	
	15:30 – 16:00	**Tea Break**		**Grand Wahid Hotel Salatiga**
	16:00 – 17:00	Malaria vectors and species complexes in Asia-Pacific: Composition, Distribution and Bionomics of Dominant Malaria Vector Species	Prof. Sylvie Manguin IRD France	Moderator : Triwibowo Ambar Garjito, S.Si.M.Kes.P.hD (online)
Wednesday 5 July 2023 (Day 3)	**Module 3: Malaria Vector Identification**			
	08:00 – 09:00	Design and Implementation of a vector surveillance programme (*continued*…)	Prof Neil Lobo	Prof Leo Braack
	09:00 – 09:40	Mosquito Morphology and Systematics (Powerpoint presentation)	Mr Mujiyono, Indonesia	Moderator : Prof Leo Braack
	09:40 – 10:10	Use of Dichotomous Keys (presentation)	Mr Mujiyono, Indonesia	

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
	10:10 – 10:30	**Tea Break**		**Grand Wahid Hotel Salatiga**
	10:30 – 11:30	Mosquito Morphology: Microscope introduction to mosquito genera – ADULTS: *Anopheles*, *Aedes*, *Culex*, *Mansonia*, *Armigeres* (Theory and laboratory session)	Triwibowo AG, S.Si, PhD, Riyani, S.Si, M.Sc, Fahmay D.A, AMKL	Moderator: Yusnita M Anggraeni Facilitators: IVRCRD &BRIN
	11:30 – 12:45	Mosquito Morphology: Microscope introduction to mosquito genera – LARVAE: *Anopheles*, *Aedes*, *Culex*, *Mansonia*, *Armigeres* (Theory and laboratory session)	Triwibowo AG, S.Si, PhD, Riyani, S.Si, M.Sc, Fahmay D.A, AMKL	
	12:45 – 14:00	**Lunch**		**Lunch Box**
	14:00 – 15:00	Dengue vectors: *Aedes aegypti* and *Aedes albopictus*: Adults, pupae, larvae (Theory and laboratory session)	Triwibowo AG, S.Si, PhD, Dr. Tanya Russell	Moderator: Yusnita M Anggraeni
	15:00 – 15:30	**Tea Break**		**Snack box**
	15:30 – 16:30	Theoretical overview of mosquito sampling techniques (adult trapping methods, larval sampling)	Prof Leo Braack	Moderator: Wulan
	Module 4: Field Sampling			
Thursday 6 July 2023 (Day 4)	08:00 – 09:00	Packing up equipment and loading into vehicles	IVRCRD team & BRIN	
	09:00 – 12:30	Travel to field location, settle into hotel in Magelang	IVRCRD team & BRIN	Hotel Artos

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
	12:30 – 13:30	**Lunch**		**Lunch box**
	13:30 – 17:30	• Set up: Human Double Net Trap, Cattle-baited Net Trap, CDC CO_2-baited Light Trap, Indoor live mosquito collections, Indoor Knockdown Spray Catches (Pyrethrum spray catches), and sites for Human Landing Catches • Larva survey/larval collection	Leo Braack and IVRCRD team & BRIN	
	17:30 – 18:30	**Packed dinner in field**		**Lunch Box**
	18:30 – 22:00	Mosquito collections	IVRCRD team & BRIN	
	22:00	Return to hotel		
Friday 7 July 2023 (Day 5)	**Module 5: Sample Processing**			
	04:30-08:00	Early morning mosquito collections (from cattle-baited traps, CDC light traps, indoor collections of live resting mosquitoes using aspirators, indoor knockdown spray catches) Return to hotel	IVCRD team & BRIN, Mr Mujiyono.	
	08:00 – 09:30	Freshen up and Breakfast		Hotel Artos
	09:30-13:00	Using mosquitoes and larvae collected in morning and previous evening, sample processing, data recording, pinning, silica-gel	IVCRD team & BRIN, Mr Mujiyono	Hotel Artos

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
		and other storage techniques for mosquito and larvae		
	13:00 – 14:00	**Lunch**		
	14:00 – 17:00	Using mosquitoes and larvae collected in morning and previous evening, sample processing, data recording, pinning, silica-gel and other storage techniques for mosquito and larvae	IVCRD team & BRIN, Mr Mujiyono	Hotel Artos
	18:00 – 19:00	**Dinner**		Hotel Artos
Saturday 8 July 2023 (Day 6)	**Module 5: Sample Processing (cont.d)**			
	09:00 – 13:00	Finalization of adult and larval processing.	IVCRD team & BRIN, Mr Mujiyono	Hotel Artos
	13:00 – 14:00	**Lunch**		
	14:00 – 17:00	Vacation around Magelang. Return to Host Institution		
	Rest and Recovery			
Sunday 9 July 2023 (Day 7)	10:00 – 11:30	Day off, discretionary personal activities.		

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
		Visit market for souvenir/traditional foods (optional, participants confirm if they want to join the group)		
	Module 6: Mosquito identification using bench aids and pictorial keys			
Monday 10 July 2023 (Day 8)	08:00 – 17:00	Use of dichotomous keys and microscopic identification of Regionally important vector mosquitoes (ONLY Malay Peninsula and PNG)	Facilitator: Triwibowo AG, PhD and Mr Mujiyono and team, Indonesia	Moderator: Yusnita M Anggraeni
	Module 7: Mosquito identification using bench aids and pictorial keys (continued…)			
Tuesday 11 July 2023 (Day 9)	08:00 – 17:00	Use of dichotomous keys and microscopic identification of Regionally important vector mosquitoes *(Continued)* ONLY Malay Peninsula and PNG)	Facilitator: Triwibowo AG, PhD and Mr Mujiyono and team, Indonesia	Moderator: Yusnita M Anggraeni
	Module 7: Mosquito identification using bench aids and pictorial keys (continued…)			
	08:00 – 08:10	Transport to the laboratory building		
Wednesday 12 July 2023 (Day 10)	08:10 – 10:00	Use of dichotomous keys and microscopic identification of Regionally important vector mosquitoes *(Continued)* (ONLY Malay Peninsula and PNG)	Mr Mujiyono and team, Indonesia	Moderator: Yusnita M Anggraeni
	10:00-10:15	**Tea Break**		**Grand Wahid Hotel Salatiga**
	10:15-13:00	Use of dichotomous keys and microscopic identification of Regionally important vector	Mr Mujiyono and team, Indonesia	Moderator: Yusnita M Anggraeni

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
		mosquitoes *(Continued)* (ONLY Malay Peninsula and PNG)		
	13:00 – 14:00	**Lunch**		**Grand Wahid Hotel Salatiga**
	Module 8: WHO Insecticide Susceptibility Assays			
	14:00 – 15.00	1. The need to monitor insecticide resistance (virtual presentation) 2. Overview of WHO tube assay and WHO Bottle bioassay (virtual presentation)	Dr Rajpal Yadav	Moderator: Prof Leo Braack Online IVRCRD hall
	15.00 – 15.15	Tea Break		
	15:15 – 17:30	WHO tube, CDC bottle bioassays, and Cone bioassay test (4 groups: 5 delegates per group): Setting up of tubes and bottles and initial exposure of mosquitoes	IVRCRD team & BRIN (lab session)	Moderator: Siti Alfiah, SKM, M.Sc
	Module 9: Insectary Management			
	08:00 – 08:10	Transport to the laboratory building		
	08.10 – 08.40	Lecture on Methods and basic infrastructure for mosquito colony establishment and maintenance in IVRCRD insectary.	IVRCRD team	Moderator : Lulus Susanti,SKM,MPH
Thursday 13 July 2023	08:40 – 10:00	Visit to insectary, rotating groups to receive exposure to:	IVRCRD team , Mr Mujiyono	IVRCRD Laboratories

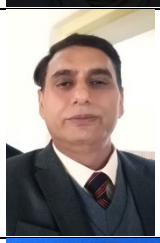
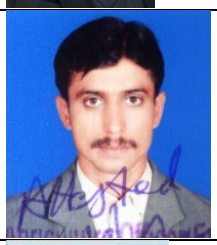
DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
(Day 11)		Group 1. Demonstration of colony maintenance techniques, Mosquito feeding and colony hygiene, and Specialized techniques: Group 2. Forced mating & insemination, oviposition etc. Group 3. Mosquito artificial feeding (genuine pig)		
	10.00 – 10.15	**Tea Break**		
	10.15 – 12.00	Visit to insectary, rotating groups to receive exposure to: Group 1. Demonstration of colony maintenance techniques, Mosquito feeding and colony hygiene, human ethics issues. Specialized techniques: Group 2. Forced mating & insemination, oviposition etc. Group 3. Mosquito artificial feeding (genuine pig)	IVRCRD team & BRIN	IVRCRD Laboratories
	12:30 – 13:30	**Lunch**		**Lunch Box**
	13:30 – 15:00	Post 24-hour insecticide exposure results: WHO tube and bottle bioassays (5 groups)	IVRCRD team & BRIN	
	15:00 – 15:30	**Tea Break**		
	15:30 -16:30	Quality control of *Anopheles* spp identification: demonstration and practice in transferring specimens from WHO tube and bottle assays to	IVRCRD team & BRIN	IVRCRD Laboratories

DATE	TIME	AGENDA	SPEAKER	FACILITATORS / VENUE
		micro-centrifuge tubes for dispatch, recording form, and SOP		
	19:00 – 22:00	**Certificate & Photo Presentation, Course Dinner, and cultural night (if possible)**	**Photographer**	For cultural night, it is suggested that the organiser to remind participants to bring their national/traditional costumes.
	Module 10: Molecular Identification techniques			
	08:00 – 08:10	Transport to lecture/laboratory building		
Friday 14 July 2023 (Day 12)	08:10 – 10:15	Overview of PCR and ELISA techniques for malaria vectors and parasites, visit to PCR lab and sporozoite identification	Mr Boni Sebayang	Moderator: Lulus Susanti
	10:15 – 10:30	**Tea Break**		
	10:30 – 12:00	Overview of PCR and ELISA techniques for malaria vectors and parasites, visit to PCR lab and sporozoite identification *(continued)*	Mr Boni Sebayang	Moderator: Lulus Susanti
	12:00 – 13:00	**Lunch**		**Lunch Box**
	13:30 – 14:00	Post-test / Course Evaluation and closing.		Prof Leo Braack
		Participants depart		

Annexure 2: Student Cohort

No	Country	Name	Photo	Designation/Department
1	Indonesia	Ary Oktasari Yanti		Laboratory technician, Institute of Vector and Reservoir Control Research and Development, MoH
2	Indonesia	Bambang Siswanto		Entomologist, Directorate of SurveilLance and Health Quarantine, Directorate General of Disease Prevention and Control, MoH
3	Indonesia	Didit Haryanto		Program Manager of Malaria and Arbovirosis, Provincial Health Office of South Sumatera
4	Indonesia	Eleazar Thandi Sallata		Head of malaria program and Vector Control in Sumba Barat district, Health District Office West Sumba
5	Indonesia	Evi Sulistyorini		Medical Entomologist, Institute of Vector and Reservoir Control Research and Development, MoH
6	Indonesia	Fahmay Dwi Ayunigrum		Laboratory technician, Institute of Vector and Reservoir Control Research and Development, MoH

7	Indonesia	Lalu Simbawara		Medical Entomologist, Health District Office West Nusa Tenggara Province
8	Indonesia	Lulus Susanti		Entomologist, Institute of Vector and Reservoir Control Research and Development, MoH
9	Indonesia	Martyna Widya		Entomologist, Directorate of SurveilLance and Health Quarantine, Directorate General of Disease Prevention and Control, MoH
10	Indonesia	Nurul Muhafilah		Health Entomologist, National Malaria Programme MoH Indonesia
11	Indonesia	Poppy K G Tyas Kusuma		Entomologist, National Malaria Programme MoH Indonesia
12	Indonesia	Riyani Setiyaningsih		Entomologist, Institute of Vector and Reservoir Control Research and Development, MoH
13	Indonesia	Dr Wimbi Kartika Ratnasari		Medical doctor, Institute of Vector and Reservoir Control Research and Development, MoH

14	Indonesia	Trianta Wati		Health Entomologist, Health Quarantine Office Manokwari Papua
15	Malaysia	Anisah Binti Seharing		Entomologist, Ministry of Health Malaysia
16	Malaysia	Khairunnisa Syaripuddin		Public Health entomologist, Ministry of Health Malaysia
17	Pakistan	Muhammad Asif Mahmood		Entomologist, Directorate of Malaria Control
18	Pakistan	Muhammad Ziaul Hassan		Medical Entomologist, Directorate of Malaria Control
19	Papua New Guinea	Mark Stephen Gideon Aruai		Vector Borne Disease Surveillance Officer, PNGIMR.
20	Timor Leste	Horacio Da Assuncao		Junior Entomology Officer, Communicable Disease Control Department

21	Timor Leste	Manuel Belo Sarmento		Senior Entomology Officer, Communicable Disease Control Department
22	Timor Leste	Moizes Amaral Magalhaes		Junior Entomology officer, Communicable Disease Control Department

Annexure 3: Pre- and Post-Course Questionnaire

Participants knowledge test

Full name : _____
E-mail address : _____

Choose the correct answer.

1. The mosquito species that is **NOT** of importance in the Indo-Malay Region…
   a. *Anopheles stephensi*
   b. *Anopheles maculatus*
   c. *Anopheles farauti*

2. When is *Aedes aegypti* most active?
   a. Between dusk and midnight
   b. Between midnight and dawn
   c. Early morning and late afternoon

3. A fully gravid mosquito is one that…
   a. Has eggs within her ovaries ready for laying.
   b. Is fully fed with a bloodmeal.
   c. A female that is receptive for a male.

4. Alpha-Cypermethrin and Deltamethrin belong to the following class of insecticides…
   a. Pyrethroids
   b. Organophosphate
   c. Carbamates
   d. Organochlorine

5. Long-Lasting Insecticide-treated bedNets (LLIN'S) should be replaced after…
   a. One year
   b. Three years
   c. Five years
   d. Seven years

6. In female Anopheles the maxillary palps are…
   a. About the same length as proboscis
   b. Shorter than the proboscis
   c. Longer than the proboscis

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

a. Culex
b. Phlebotomus
c. Aedes
d. Toxorhynchites

8. The tarsae of a mosquito are part of the _____ of a mosquito.
   a. Head
   b. Wings
   c. Legs
   d. Abdomen

9. Male mosquitoes have antennae that are far more plumose (“hairy”) than the females.
   a. True
   b. False

10. Where would you expect to find the tergum of an insect:
    a. Laterally
    b. Ventrally
    c. Dorsally

11. Where would you expect to find the pleuron of a mosquito:
    a. Laterally
    b. Ventrally
    c. Dorsally

12. Where would you expect to find the sternum of a mosquito?
    a. Laterally
    b. Ventrally
    c. Dorsally

13. Both male and female mosquitoes take bloodmeals
    a. True
    b. False

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

15. Mosquitoes that prefer to feed outdoors are:
    a. Endophagic
    b. Exophagic
    c. Anthropophagic

16. Mosquitoes that prefer to feed on cattle are:
    a. Zoophilic
    b. Anthropophagic
    c. Endophilic

17. For the standard WHO and CDC insecticide susceptibility tests, the final definitive mortality is checked at…
    a. 60 minutes
    b. 12 hours
    c. 24 hours
    d. 72 hours

18. Plasmodium oocysts develop on the wall of the mosquito's _____.
    a. Salivary gland
    b. Midgut
    c. Proboscis
    d. Ovary

19. Plasmodium malaria parasites can survive transovarial transmission in mosquitoes.
    a. True
    b. False

20. Anopheles species complexes have the following characteristic:
    a. The same degree of Anthropophily.
    b. They are morphologically very similar but genetically distinct.
    c. 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.
    a. True
    b. False

22. Which method is still regarded as the "Gold Standard" of malaria vector sampling?
    a. Human-decoy trap
    b. CDC light trap
    c. Human Landing Catches

23. Anopheles larvae in a pool of water mostly…
    a. Float with their body horizontal and parallel to the surface of the water
    b. Float with their head down below water and tip of abdomen at the surface of the water
    c. Stay at the bottom of the pool.

24. Temperature and humidity inside the Insectary should be as close as possible to…
    a. 20 Centigrade, 95% humidity
    b. 27 Centigrade, 75% humidity
    c. 34 Centigrade, 50% humidity

25. How often do female Anopheles mosquitoes need a bloodmeal?
    a. Only once during their life, that is enough.
    b. Every time they mate with a male.
    c. For every cycle of egg-laying

References

1. Burkot TR, Farlow R, Min M, Espino E, Mnzava A, Russell TL. A global analysis of National Malaria Control Programme vector surveillance by elimination and control status in 2018. Malaria Journal. 2019;18(1):399.
2. Russell TL, Farlow R, Min M, Espino E, Mnzava A, Burkot TR. Capacity of National Malaria Control Programmes to implement vector surveillance: a global analysis. Malaria Journal. 2020;19(1):1-9.
3. Mnzava AP, Macdonald MB, Knox TB, Temu EA, Shiff CJ. Malaria vector control at a crossroads: public health entomology and the drive to elimination. Transactions of The Royal Society of Tropical Medicine and Hygiene. 2014;108(9):550-4.
4. Rajagopalan P. Medical Entomologists-A Disappearing Profession in Public Health System: Indian Perspective. Journal of Communicable Diseases (E-ISSN: 2581-351X & P-ISSN: 0019-5138). 2022;54(1):161-5.
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